

## A Jesuit Cosmological Textbook in ‘Christian Century’ Japan: *De sphaera* of Pedro Gomez (Part II)

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### Introduction

This paper provides a new critical Latin edition and the first English translation of Pedro Gomez’ *De sphaera*, Part 2, which is titled “On the sublunary world.”<sup>1</sup> It deals with the four elements and meteorological phenomena, while the previously-published text of Part 1 treats the celestial world.<sup>2</sup> In the following introduction, we would like to focus upon 1) the Author, Pedro Gomez, 2) the Vatican manuscript, and 3) Francisco Titelmans’ *Compendium philosophiae naturalis* as one of its European sources.

#### I. About the Author: Pedro Gomez

Pedro Gomez was born in Antequera in the province of Malaga, Spain, in 1533/1535.<sup>3</sup> Sources suggest that he was born into a family of *converso* Jews.<sup>4</sup> He studied at the University of Alcala and entered the Society on 21<sup>st</sup> December 1553 in Alcala de Henares. His teaching career began at the Jesuit College of Arts in Coimbra (Colegio das Artes), where he taught liberal arts from 1555 to 1563. Among his colleagues was Pedro da Fonseca (1528-1599), known as the Portuguese Aristotle. During this period, Gomez was conferred, together with Fonseca and others, the degree of *Maestro* in 1557 and was ordained in the summer of 1559. According to a report from the same year, he was esteemed to have been highly intelligent and creative, and exceptionally skilled in the teaching of liberal arts. For the four-year course of 1559-1563, Gomez taught the following subjects: first year, dialectics; second unknown; third physics and *De caelo*; fourth metaphysics. Around this period, he was also involved, by the order of Jeronimo Nadal (1507-1580), in the compilation of a philosophical treatise—a project which was led by Fonseca and later published as *Institutionum dialecticarum libri octo* (Lisbon, 1564). It is still an open question whether

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<sup>1</sup> While Gomez’ Latin text (with an accompanying Japanese translation) is already available in Obara 1965, our new critical edition, based on the facsimile of the Vatican manuscript, contains a number of significant departures from this predecessor; see our discussion and text below.

<sup>2</sup> Hiraoka 2005.

<sup>3</sup> Historians do not agree on his birth year: 1533 or 1555. For the biographical data of Gomez, we relied on the following studies unless specified otherwise. Schütte 1939, 235-242; López Gay 1986, 50-53; Sakuma 1996, 4-12; Üçerler 1997, 30-31.

<sup>4</sup> Oka 2013, 38-43.

Gomez took part in the activities which began around this time and later led to the composition of the famous Coimbra Commentaries of Aristotle (known as *Conimbricenses*). We can at least note, however, that Gomez's *De sphaera* and the Coimbra commentary of *De caelo* had one distinct characteristic in common: the cubic shape of the convex surface of empyrean heaven.<sup>5</sup>

From 1564, he started to teach theology at the same college over a 3-year period. Again, he was highly esteemed not only as a theology teacher, but also as a priest and a preacher. In 1570, he moved to Terceira island in the Azores archipelago to establish a new college, where he taught *Casos* (moral theology) until 1579. In this year, Gomez's wish to be sent on a mission to Asia was finally granted, although he had made the application already in 1563. The Jesuit Order of the time had a policy of excluding members of Jewish lineage from important positions by, for example, sending them on foreign mission.<sup>6</sup> It is possible that Gomez' delayed dispatch to Japan had something to do with his origin.

After leaving Lisbon, he spent some time in India, and reached Macao in 1581. In Macao, he assisted the Italian Jesuit Michele Ruggieri (1543-1607) in compiling a Chinese catechism.

In the summer of 1583, Gomez finally arrived in Japan. Upon his arrival, he was appointed by Alessandro Valignano (1539-1606), the Jesuit *Visitador* of the East India mission, to be the *Superior* of the Bungo region, nowadays Oita, and worked at the Jesuit college of Funai in the region. It was under the supervision of Gomez that the first official course of philosophy or liberal arts began in October of the same year. In the spring of 1585, when the philosophy course was finished, he introduced a program of theological study. But it was interrupted because of the political turmoils and the college itself was forced to move from place to place, until it was settled in Amakusa, nowadays Kumamoto, in 1591. Under this difficult situation, Gomez became the Vice-provincial of the Jesuit mission in Japan in 1590.

In 1593, Gomez finished writing his *Compendia*. They were composed of three separate treatises: 1) *De sphaera*, dealing with cosmology; 2) *De anima* (On the Soul) heavily based on Aristotle's work of the same title; and 3) *Compendium catholicae veritatis* (Compendium of the Catholic Faith) on theological matters. Sources show that the *Compendia* were compiled specifically as a textbook for the European and Japanese students and were used at Jesuit colleges in Japan as well as in Macao.<sup>7</sup> They were indeed the first substantial work that directly introduced Western science, philosophy and theology into Japan.

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<sup>5</sup> Mori 2001, 84-86; Hiraoka 2013, 42-55.

<sup>6</sup> Maryks 2010, 117-143.

<sup>7</sup> Contrary to the scepticism of Ugo Baldini on the possible usage of Gomez's *Compendia* in Macao, we can at least cite two sources which assert that they were read in the college around from 1614 to 1616 to the *dojukus* who came from Japan, as reported by Antoni Üçerler. Baldini 2008, p. 50, n. 57; Üçerler 1997, 47-48. In this illuminating paper, Baldini asserts that *Kenkon bensetsu* was "published", but the work was never published during the Edo period. It was in fact first published in 1914. See Baldini 2008, 46, 52; Hiraoka 2008, 92-96; Hiraoka 2013, 129-155.

## II. Vatican Manuscript

The sole surviving manuscript of our text is the codex Reg.Lat.426 in the Vatican Library. The cover of the codex is 25.0cm.high, 17.1cm.wide, and 4.9cm.thick, while each folio is 24.0cm.high and 16.0cm.wide. The manuscript codex entered the Vatican Library as part of the Swedish Queen Christina's collection in the seventeenth century, and little is known about its provenance.<sup>8</sup> Its content, however, as well as the paper used, which will be discussed shortly, do point to an East Asian origin.

The manuscript text is written in the usual European manner. Each folio is written on both sides in dense, practiced script, with an average of 35-36 lines per page in *De sphaera*. In the original manuscript, one can still see blind lines ruled on each page with a hardpoint as guide to keep the script straight.

Wilmart, who cataloged the codex in 1950, describes it as the autograph manuscript of Pedro Gomez.<sup>9</sup> López Gay however in his 1966 publication disagrees with this assessment.<sup>10</sup> After carefully examining the codex, we have come to believe together with López Gay that what we have is not the authorial autograph, for the following two reasons.

First, as the first author of the present article (RH) has shown in a separate publication, the manuscript is written in several distinct hands. Indeed, just in *De sphaera*, we can see at least three different hands, working in successive chunks to produce the text.<sup>11</sup> On the other hand, one would obviously assume an authorial autograph to consist of a single hand.

Our second reason is the far from perfect quality of the extant manuscript text. When the text is examined closely, it reveals gross imperfections which seem incongruous for an accomplished European academic like Pedro Gomez. Interchanges between l's and r's are numerous, some of which are corrected (f.29r., f.30v., f.31v.) but many not (f.21v., f.22r, f.26v., f.27r., f.30v., f.35r., f.36r., f.36v., f.38r.). There are also egregious grammatical errors (f.20r., f.20v., f.29v., f.37v.) and other instances, such as a portion of the text left blank (f.21r., cf. also the crux in f.36r.), which seem to indicate that the scribes, though their hands appear practiced and fluent, were linguistically not in full control of their material.

By "material" we mean, here, the presumed original text by Gomez, or a copy (or oral delivery) thereof. In our edition, we have tried to restore the archetype text with conjectures whenever possible. The language of this presumed archetype, which we do assume to be fairly closely approximated in the current codex despite its frequent lapses, resembles

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<sup>8</sup> Schütte 1939, 225-226, Wilmart 1950, 530.

<sup>9</sup> Wilmart 1950, 530 ("Petrus ille suus librarius fuit...").

<sup>10</sup> López Gay 1966, 137, where he sees a change in hand from f. 206v. to f.207r. He also notes the misspelled word *militali* in f.201v. and suspects that some of the scribes were Japanese. See also Sakuma 1995, 14-15 for more examples of misspellings and a suggestion that the manuscript was copied by dictation rather than by sight.

<sup>11</sup> Hiraoka 2013, 68-70.

the kind of academic and scientific Latin widely used in early modern Europe. Put simply, it is a compromise between the mediaeval scholastic tradition and the classicism of Renaissance humanism,<sup>12</sup> with limited intrusions of the early modern vernacular (in this case, Portuguese; see especially f.37v.). Our text however does seem noticeably closer to scholastic monotony and vernacular homeliness than to the humanistic polish that is displayed in contemporary printed European texts like Titelmans', of whom more will be said later. Our manuscript conveys a fairly simple variety of Latin with restricted vocabulary and unambitious syntax, which seems well suited to an audience with limited training in classical humanism.

All this leaves open the question of the nature of our manuscript codex. Is it still in a sense an authorial copy that Gomez dictated to several successive scribes? Is it a collaborative notebook of the college students listening to lectures? Is it some kind of presentation or inspection copy, perhaps in anticipation of a printing which never took place? We do not know the answer to these questions yet, but hope that future comparison with contemporary European academic manuscripts will, in time, allow us to more accurately understand the nature of this manuscript.

There are some intriguing leads however, which we can now report, and which do appear to point to an educational setting, presumably of the Japanese Jesuit college. On f.25r., there is a marginal note in Japanese but written in the Roman alphabet.

Xecaino grau 360. Noriva 6300 ri. Coreyori centro made va 1002 ri. Diametrova 2004 ri.

(世界のグラウ 360. 程は 6300 里. これよりセントロまでは 1002 里. ディアメトロは 2004 里.  
The world contains 360 *grau* [degrees]. The circumference is 6300 *ri* [a unit of distance]. From here to the *centro* is 1002 *ri*. The *diametro* is 2004 *ri*.)

Strangely, it seems to be connected not to the main body on the same page but to a passage that is on the opposite side of the folio. At the end of the codex (f.430r.-431v.), there are several irregularly shaped folios<sup>13</sup> which preserve four snippets of Latin poetry, at least one of which is nearly identical to a Jesuit poem printed in 1594.<sup>14</sup> Although Wilmert assumes these verses to have been copied by Pedro Gomez,<sup>15</sup> a more plausible assumption, in view of what we have discovered about the rest of the codex, would be that they were parts of a commonplace book or school anthology which somehow ended up being bound together with the *Compendia*.

A further mystery is the presence of 6 blank folios before the main body, and 18 blank folios after it. These are all omitted in the facsimile edition, but the presence of so many

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<sup>12</sup> See e.g. Ogilvie 2015, 264.

<sup>13</sup> The facsimile edition does not place these folios exactly as they are found in Reg.Lat.426, presumably due to constraints of modern publication.

<sup>14</sup> Compare the 14-line elegiac epigram on Longinus in f.430v. with Possevino 1594, 206, where it is attributed to one Franciscuss Raimundus, S.J.

<sup>15</sup> Wilmart 1950, 529-530.

unused folios sandwiching the main text may indicate some further planned work regarding the current codex that was never followed up.

It should also be noted that folios of the manuscript are all washi (Japanese paper), probably *Cho-shi* paper 楮紙, of peculiar characteristics. We find that small particles, such as tiny pieces of wood fiber or bark and even human hair, are mingled within most folios. This may suggest that these sheets were not new but had been recycled. Moreover, each sheet appears as if it had been pounded with a hammer to make the surface smooth and glossy (*uchigami* 打紙). Interestingly, these characteristics can also be seen in the famous Barreto Manuscript (Vatican library, Reg.Lat. 459), which was autographed by the Portuguese Jesuit Manuel Barreto (1563?-1620) in 1591 in Japan.<sup>16</sup> The folios of the two manuscripts have another characteristic in common, namely that on the overall surface of paper we observe a slight ridge-and-furrow pattern of coarse texture, which is almost blind in most folios but can rather clearly be seen in f. 117v., 195v. of Gomez's *Compendia* and in f. 104r., 383v. of the Barreto Manuscript.

Lastly, the table of contents (ff. 453-467), which is bound at the end of the manuscript, deserves particular attention. Since the folios of this part are smaller in size than those of the main text and apparently written in a different hand, it is highly likely that they are a later addition, as the editor of the facsimile edition asserted.<sup>17</sup> However, it is our sole extant primary source that identifies the title of the work as "De sphaera" (f. 453r), an identification which the main text lacks. Moreover, the folios of this part are also washi: the former half (f. 453-458) are the same as the main text, while the latter half (f. 459-467) are *Cho-shi* papers that were not pounded with a hammer. This makes it probable that this manuscript, including the table of contents, was produced in a place where washi paper could be easily acquired, such as Japan or nearby, than in Europe.

### III. Titelmans' *Compendium* as One of its European Sources

The order of chapters in Part 1 of *De sphaera* clearly resembles that of the same title by the thirteenth-century scholar Joannes de Sacrobosco. The first author of the present article (RH) has identified the main source of Part 1 as Christopher Clavius' (1538-1612) *In sphaeram Joannes de Sacrobosco commentarius*.<sup>18</sup>

As for the source of Part 2, we have so far identified Francisco Titelmans' (1502-1537) *Compendium philosophiae naturalis*. Titelmans was a Franciscan scholar who was active in the early sixteenth century in Louvain. In his compendium, Titelmans summarizes most of the Aristotelian-scholastic doctrines of the time just in one volume of around 400 pages. After the first edition of 1530, it was reprinted at least 28 times all over Europe and be-

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<sup>16</sup> Kawaguchi 2001, 79; Toyoshima 2013, 121.

<sup>17</sup> Kirishitan Bunko Library 1997, introductory remarks. This is the reason why this part was deliberately omitted from the facsimile reprint.

<sup>18</sup> Hiraoka 2005, 102-105; Hiraoka 2009.

came a popular textbook of natural philosophy in the sixteenth century.<sup>19</sup> It was also used in the Jesuit College in Coimbra around the middle of the sixteenth century.<sup>20</sup>

Titelmans' compendium was brought to Japan in the earliest stage of the mission. In the list of books which were imported in 1556 by Melchior [Belchior] Nunes Barreto (1520?-1571), we find the title of his compendium, together with Thomas Aquinas, Plato, and Aristotle.<sup>21</sup> Furthermore, his compendium had surely been put into use in the Noviciado in Usuki,<sup>22</sup> which was close to Funai college, where the first philosophical course had started in 1583. Although we have no direct evidence that the book was indeed used in the Japanese collegio, we can at least note that Gomez himself made a reference to the Biblical work of 'Titelmanus' in the theological part of his tripartite *Compendia*.<sup>23</sup>

Table 1 is a single example of a textual comparison of Gomez and Titelmans from the section on earthquake. In the sentences that we have underlined to mark corresponding texts, we find a good agreement, except for such minor variations as verb conjugations and noun declensions. The same can be said of Table 2, from the section on parhelia. Such correspondences suggest that Gomez consulted Titelmans' work when drafting *De sphaera*.

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<sup>19</sup> Thorndike 1923-1958, vol. V, 147-152; Lohr 1988, 456-458; Schmitt 1988, 795-796.

<sup>20</sup> Gomez Dos Santos 1955, 475-476; Lines 2008, 193.

<sup>21</sup> López Gay 1959-1960, 367-369; Verwilghen 1961.

<sup>22</sup> Takase 2012, 372-373.

<sup>23</sup> Sakuma 1996, 31-32.

Gomez, f. 38r.	Titelmans 1564, 157-158.
<p>Terremotus fit hoc modo: <u>Virtute solis et aliorum astrorum generantur plurimae exhalationes in concavitatibus terrae, quae ita inclusae egredi nequeunt, eo quod terra nimis compacta sit ob frigiditatem circumstantem aut pluviam praecedentem, exitumque petentes terram concutiunt, et ita terrae motum efficiunt; qui si in latus fiat, tremor dicitur, si vero elevatio fit collis in altum, dicitur pulsio; quo terrae motu contingit civitates opprimi, sicut contigit Arequipae civitati Peranae annis 1579. Fiunt etiam montes aut evertuntur. Tremor autem frequentior est quam pulsio, habetque durationem iuxta exhalationum magnitudinem et firmam solidamque terrae compactionem. Signa futuri terremotus sunt, si mare nullo vento spirante subito intumescat, et si aquae in imo puteo turbulentae sint; interdum vero solet cum terremotu egredi flamma, aut quia exhalatio magno impetu egrediens inflammatur, aut quia in visceribus terrae continetur aliqua pars sulfurea terrae, quae simul cum exhalatione per motum illum inflammatur; quandoque accidit, ut cum terrae motu tanta cinerum copia egrediatur, ut agros operiat, ut contigit in insulis Tertiariis anno 1580 et alibi saepe; non quod cineres tum generantur, sed ibi relictis sunt ab inflammatione sulfuris in dictis ardentis, qui postea pelluntur motu terrae facto; in quibus locis frequenter fiunt terrae motus propter vim ignis, qua etiam ratione pulvis sulfureus turribus suppositus et incensus eos evertit sursumque pellit.</u></p>	<p>Quando autem contingit intra viscera terrae plurimas generari exhalationes in concavitatibus ipsius per virtutem Solis atque astrorum ex materia ipsius terrae et humiditatis terrae immersae, si egredi nequeant, ob nimis compactam terram, et nimiam ventorum grossitiem, necesse est terrae fieri motum in aliqua parte. Qui si in latum fiat, tremor dicitur: ubi vero elevatio fit collis in altum, dicitur pulsio. Et hoc terraemotu contingit civitates opprimi, et montes generari, et etiam subrui. Neque est mirandum, tantam habere vim exhalationem inclusam intra terram, quoniam videmus ex modicis spiritibus in hominibus exitum quaerentibus, magnos subinde tremores fieri. Auditur autem aliquando sonus multo ante terraemotum, ex concussionem exhalationis ad latera terrae genitus. Caeterum durationem habet iuxta exhalationis magnitudinem, et firmam solidamque terrae compactionem. Signa aliquot futuri terraemotus sunt, Primum, si mare nullo vento spirante subito intumescat. Secundum, si aves solo pavidae insideant. Tertium, si aquae in imo puteo turbulentae sunt.</p>

Table 1. Textual comparison between Gomez and Titelmans (On earthquake)

Gomez, f. 36v.	Titelmans 1564, 161.
<p>Pareleae fiunt, cum nubes diaphana et aliqua ex parte terminata opaca et uniformis posita <u>fuert non sub sole, neque ex opposito, sed ad eius latus iamiam parata, ut in pluviam vertatur; in illa solet imprimere sol suam imaginem per radorum refractionem</u>, sicut in speculo; dictum est nubem debere esse aliqua ex parte terminatam et opacam, ut ab ea possit fieri reflexio specierum ad nostrum oculum; debet quoque esse uniformis, ut perfectior solis imago imprimatur, debet esse iam parata, <u>ut in pluviam vertatur, ut commodius in [ea] representetur solis imago, sicut in aqua perlucida</u>; nondum tamen debet esse versa in aquam, quia non esset terminata, et proinde <u>non posset solis imaginem exprimere</u>. Interdum solent esse duae huiusmodi nubes iuxta solem, una ex hoc latere et altera ex alio, quo modo videntur esse tres soles, unus verus et duae imagines ipsius.</p>	<p>Caeterum parahelij generantur ad hunc modum. Cum enim nubes bene densa et continua, regularis et uniformis, sita <u>fuert non sub sole, neque ex opposito, sed ad latus eius propinqua, ut vertatur in pluviam</u>, nondum tamen versa, <u>in illa sol per suorum radorum refractionem</u> suam exprimit, formatque imaginem, sicut suam imaginem effingit sol in aere polito et bene terso. Haec autem imago solis ad eius latus consistens, dicitur parahelius, a para, quod Graecis iuxta significat, et helios, quod solem: ut dicatur parahelius, quasi iuxta solem. Dictum est autem nubem illam debere esse densam, ut melius refractionem faciat continuam, ut integriorem solis suscipiat imaginem: regularem quoque et omnino ut magis uniformem veriore et perfectiorem exprimat imaginem propinquam etiam <u>verti in pluviam, ut commodius in ea repraesentetur solis imago, sicut in aqua pellucida</u>, attamen nondum conversam: quia si conversa iam esset, partibus discontinuatis <u>non esset apta solis imaginem suscipere neque exprimere</u>.</p>

**Table 2.** Textual comparison between Gomez and Titelmans (On parhelia)

On the other hand, in Table 1, those texts which are not corresponding, that is, not-underlined, we find only in Gomez—such as information on the earthquake which he says happened in 1579 in Arequipa, Peru, and the volcanic ash that fell in 1580 in Terceira island in Azores. This may imply that Gomez, as a textbook writer, tried to give a concreteness to his explanation of earthquakes by adding actual examples that had happened in recent years.

It should further be noted that *De sphaera* might have been influenced by Titelmans' work in its nature and structure as an elementary textbook of natural philosophy. While the underlying natural philosophy is Aristotelian and scholastic, the most conspicuous charac-



ter of Titelmans' textbook is its brevity and religious overtones, as Lynn Thorndike has rightly summarized.<sup>24</sup>

For brevity, Titelmans says in the preface that he drew up a brief and concise compendium for the "simple brothers" of the Franciscan Order, whose time was so taken up by their religious duties that only a minimum was available for the study of philosophy, and an insufficient one to read "prolix and difficult commentaries".<sup>25</sup> Apparently, such a textbook was in much greater demand for the Japanese college, which not only did not have such mature system of education as that of its European counterpart but also had difficult problems of its own such as the language barrier, social unrest and the paucity of books and teachers and so on.

As for its religious overtones, Titelmans says:

This treatise may not be one of pure philosophy, but an equal mixture of philosophy and theology. For God who created heaven and earth should not be absent from the works of any Christian writer. Just as God created everything, filling it up with his majesty, so He also includes everything, which is blessed for long. Amen.<sup>26</sup>

The religious character of his compendium is evidenced not only by abundant insertions of biblical quotations but also by the 'Psalms' of his own composition which are appended to each component book.<sup>27</sup> Gomez' *De sphaera*, on the other hand, is not so much filled up with biblical quotations as Titelmans, but at least we cannot dismiss the fact that the famous passage from Romans 1:20 is quoted in both prefaces of Titelmans and Gomez, as if it were a keynote theme for both textbooks.

[Titelmans 1564, 9]

Indeed, as the Apostle writing to Romans says, "For invisible attributes of God, namely, his eternal power and divinity, have been clearly perceived in the things that have been made ever since the creation of the world. So those people are without excuse, who did not learn, from the knowledge of creatures, to show gratitude that the Creator deserves, nor to be obliged to serve [Him] by labor [*Romans* 1:20]." For, as the Book of Wisdom attests, "For from the greatness and appearance of created things comes a perception of the Creator by the admirable work as this world has [*Wisdom* 13:5]".

[Gomez (Hiraoka 2005, 108-109)]

As the Apostle says, "Invisible attributes of God are clearly perceived in these visible things, namely, the machine of the world and the perpetual and immutable order of the heavens [*Romans* 1:20]". Therefore [...] now we shall also give a brief account of the knowledge which can be attained through the creatures: that is, the nature, motion and influence of the heavens, the [four] elements and this inferior world. For with regard to them, the Prophet especially says "The heavens declare the glory of God" [*Psalms* 18:2] etc.

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<sup>24</sup> Thorndike 1923-1958, vol. V, 147-152. See also Schmitt 1988, 795-796.

<sup>25</sup> Thorndike *op. cit.*, 148; Titelmans 1564, 3.

<sup>26</sup> Thorndike *op. cit.*, 150; Titelmans 1564, 10.

<sup>27</sup> Lines 2008, 187-190.

Without doubt, these two textbooks had a clear purpose in common: to make their readers reach the notion of the invisible God through the knowledge of visible things in this world.<sup>28</sup>

Lastly, we may point out that the topics which are discussed in Part 1 of *De sphaera* mostly correspond to those in Book 7 of Titelmans' *compendium*, while those in Part 2 of the former to those in Book 6 of the latter (See Appendix). Since it seems Gomez had consulted Titelmans while composing his own, the topics treated in each part of *De sphaera* may also have been influenced by the Franciscan textbook.

### Editorial principles:

- The Latin text is based on the facsimile reprint edition of the sole extant manuscript (*Ms.*): Kirishitan Bunko Library 1997. The figures in the text are copies taken from the same edition.
- It is certain that the *Ms.* is not the authorial autograph (see the discussion above). The editors also assume that it is not the archetype.
- The present edition attempts to reconstruct the hypothetical archetype (to the extent possible) based on the *codex unicus*.
- Significant variants in *Ms.* and *Obara* are noted in footnotes.
- All manual corrections in the *Ms.* are also noted in footnotes.
- On the other hand, orthographic variations (e.g. de-/dis-, oe/ae/e) in the *Ms.* and *Obara* that do not significantly alter the meaning of the text are silently corrected and standardized.
- The editors likewise silently standardize the punctuation.

### Abbreviations and sigla:

<i>Ms.</i>	Vatican MS. Reg. lat. 426 [facsimile edition: Kirishitan Bunko Library 1997].
<i>Obara</i>	Obara's edition [Obara 1965, (1)–(78)].
#	Something illegible scratched out.
⊖	a (etc..) scratched out
\a/	a (etc..) inserted
+	crux

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<sup>28</sup> As for the place and role of cosmology in overall Jesuit mission plan in Japan, see Hiraoka 2013, 19-42; Hiraoka (forthcoming).



[f.20r.]

**Secunda pars de mundo sublunari  
de elementis simplicibus et mixtis. Caput Primum.  
De elementorum natura, figura, numero atque  
loco –**

Egimus de caelesti regione, quae praecipua mundi pars est, nullique alterationi subiacet. Nunc de sublunari, quae omni mutationi et corruptioni subest, de elementis simplicibus et mixtis aliquid agemus. Et primo quidem de elementis in communi, deinde de mixtorum causis, tertio de his mixtis seu impressionibus, quae in unoquoque elemento in particulari fiunt, aliquid dicemus.

§1<sup>01</sup>

Sunt autem elementa corpora quaedam simplicia homogenia, ex quorum commixtione diversae generatorum species<sup>2</sup> fiunt. Corpora esse dicuntur, ne elementa materiam primam esse putemus. Materia enim prima, nec corpus nec perfectum aliquid est, sed medio-ens ut alibi diximus. Elementa vero vera corpora sunt, ex materia et forma composita, quorum formae non sunt quattuor qualitates, frigiditas scilicet siccitas etc., sed unumquodque elementum propriam<sup>3</sup> [f.20v.] habet substantialem formam et naturam suam, quam<sup>4</sup> tales requirit qualitates et non alias, habetque proprias operationes, operationibus aliorum elementorum distinctas, ita ut verbi gratia forma aquae frigiditas non sit. Amissa sua frigiditate adhuc vere et proprie aqua est, immo per propriam formam, nullo alio infrigidante, se in pristinam frigiditatem reducit.

Secundo dicuntur esse simplicia corpora et homogenia, simplicia quidem quia ex aliorum elementorum mixtione non fiunt, homogenia vero, quia non habent partes diversae rationis, sicut ex ossibus et carne componimur<sup>5</sup> atque pelle, sed quaelibet pars aquae aqua est.

Tertio dicuntur indefinita, ex quorum mixtione et corruptione multa fiunt. Deus enim mundum creans prius simplicia haec produxit corpora, deinde ex eis alia omnia construxit, et ideo elementa dicuntur, quasi principia sint, ex quibus omnia alia componuntur. Hoc autem ita intelligendum est, non quod quattuor elementa secundum proprias formas in hoc verbi gratia vel in alio mixto reperiantur, sed quod ex illorum materia, virtute generantis attemperata et disposita iis quattuor qualitibus elementorum, omnium mixtorum corpora resultant ut capite sequenti dicemus.

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<sup>1</sup> *Sic Ms., inseruit Obara* De elementorum natura, figura, numero et loco.

<sup>2</sup> *Correximus ex superstes. Cf. Sacrobosco Tractatus de Sphaera* Cap. I (Thorndike 1949, 78).

<sup>3</sup> *Ms. proprium, correxit Obara.*

<sup>4</sup> *Sic Ms.; fortasse pro quae vel quod, sed cf. OLD s.v. quam 6.*

<sup>5</sup> *Correximus ex Ms. Obara* componitur.

[f.20r.]

**Part Two, on the sublunary world,  
on simple elements and composites. Chapter One.  
On the nature, shape, number  
and locus of elements -**

We have discussed the celestial region, which is the chief part of the world, and is subject to no alteration. Now we shall hold some discussion concerning the sublunary region, which is subject to every change and corruption, and concerning the simple elements and composites. And we shall say something firstly about the elements in general, then about the causes of the composites, and thirdly, about those composites or impressions which occur in every element in particular.

**§1**

The elements are certain simple homogeneous bodies, out of whose commixture diverse species of generated things arise. They are called bodies, lest we think that elements are prime matter, For prime matter is neither a body nor something perfect, but is a *medio-ens*, as we have said elsewhere. On the other hand, elements are true bodies, composed of matter and form, whose forms are not the four qualities, namely coldness, dryness, etc., but each element [f.20v.] has its own substantial form and nature, such qualities as it requires and not others, and it has its own operations that are distinct from the operations of other elements, in such a way that, for example, the form of water is not coldness. With its coldness lost, it is still truly and properly water, but rather through its own form, even if nothing else makes it cold, it reduces itself to its pristine coldness.

Secondly, they are said to be simple and homogeneous bodies, simple on the one hand because they are not made from a mixture of other elements, and homogeneous on the other hand because they do not have parts of diverse manner, as for example we are put together from bones and flesh and skin, but whatever part of water is water.

Thirdly, they are said to be indefinite, from whose mixture and corruption many things arise. For God, when He made the world, first produced these simple bodies, then he constructed everything else from them, and for this reason they are called elements, as if they were principals, out of which everything else is composed. This must, however, be understood in the following way, namely not that the four elements according to their own forms are found in this, for example, or that composite, but that out of their matter, tempered and disposed with those four qualities of the elements by the power of the generating being, the bodies of all composites result, as we shall say in the following chapter.

## §2.

Quattuor autem esse mundi elementa et non plura<sup>1</sup> omnium nationum consensus obtinuit, terram scilicet et aquam, quae crassiora et sensibilia sunt, aerem deinde et ignem, subtiliora et minus sensibilia. Quibus ita quattuor primas qualitates attribuunt, ut terra sicca sit in summo, frigida prope summum, unde omnium crassior, gravior et infima est. Aqua deinde frigida est in summo, humida vero prope summum. Aeri<sup>2</sup> humiditatem in summo et calorem citra summum attribuunt, unde terra multo levior et subtilior est. Ignis vero calorem summo et siccitatem prope summum continet, unde et omnium rarissimus levissimus est. De tribus prioribus elementis dubium non est, deinde vero utrum verus [f.21r.] ignis dicatur elementalis, specialis posset esse difficultas, neque enim videtur esse ignis alius praeter hunc nostrum usuaem, flammam scilicet et prunam. Si enim ignis esset aliqua regio suprema, cum ignis sit maxime activus, aerem et omnia alia facile consumeret, deinde cum lucidus sit ex natura sua facile a nobis conspici posset, ulterius autem non habeat [ ]<sup>3</sup> in regione suprema facile deficiet, sicut oleo deficiente lucerna deficit.<sup>4</sup>

Verum respondetur cum communi philosophia negari non posse ignis regionem esse supra aerem, licet enim ad oculum non videatur, id tamen ratio et experientia suadent,<sup>5</sup> sicut aerem nemo videt, an autem sit vel non, nemo dubitat. Probatur autem primo quia calor est omnium quattuor qualitatum perfectissimus, nec in alio elemento reperitur in sua perfectione, sive in aere, sive in terra, sive in aqua; est ergo quartum elementum ignis quod calidissimum, siccum et omnium levissimum sit; confirmatur quia maxime hoc conveniens erat ad perfectionem universi, ut sicut datur elementum summe frigidum, ita etiam aliud daretur summe calidum. Deinde unicuique elemento est assignatus a natura suus proprius locus, ita ut dum in suo loco est, omnino quiescat, et dum extra illum, + violentus est quodammodo inquietus +<sup>6</sup>; sed ignis noster usualis flamma scilicet licet clarior sit aere propter vapores admixtos, semper tamen sursum ascendit, nec umquam descendit, aut quiescit; eius ergo proprius, naturalis locus terra non est, sed supra aerem; argumentum hoc a signo,<sup>7</sup> optimum est, sicut enim quis bene colligeret, omnes rivi naturaliter in aliquam decurrunt partem, est ergo ibi summa congregatio aquarum, earumque locus proprius, ita etiam omnis ignis naturaliter<sup>8</sup> superius ascendit, est ergo ibi naturalis eius locus etc.

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<sup>1</sup> *Correximus ex Ms. Obara plus. Cf. e.g. Toledo 1585, 314.*

<sup>2</sup> *Correxit Obara ex aer.*

<sup>3</sup> *Spatium fere duorum verborum vacuum relictum in Ms, fortasse legendum: ...habeatens [nutrimentum] vel [pabulum] in regione... Cf. e.g. Titelmans 1564, 171; Colégio das Artes (Coimbra, Portugal) 1603, 463, 465.*

<sup>4</sup> *hinc manu alia scriptum est.*

<sup>5</sup> *Ms. suadenat.*

<sup>6</sup> *Sic Ms.; fortasse pro violentum est quodammodo inquietum, vel violetur et quodammodo inquietetur.*

<sup>7</sup> *Correximus ex Ms. Obara assigno.*

<sup>8</sup> *Ms. ...etiam omnis naturaliter..., Obara ...etiam ignis naturaliter... Inseruimus ignis.*

**§2.**

Indeed, the consent of all nations has prevailed that there are four elements of the world and not any more, namely earth and water, which are denser and more perceptible, and then air and fire, which are more subtle and less perceptible. To these elements are attributed the four prime qualities, such that earth is dry in the highest degree, cold near the highest degree, whence it is denser, heavier and lowest of all. Water then is cold in the highest degree, but humid near the highest degree. To air is attributed humidity in the highest degree and heat below the highest degree, whence it is much lighter and subtler than earth. Fire contains heat in the highest degree and dryness near the highest degree, whence it is the rarest and lightest of all. On the first three elements there is no doubt, but then whether the true **[f.21r.]** fire may be called an element there might be a special difficulty, for indeed the fire does not seem anything other than our usual one, namely flame and a red glow. For if the fire were some uppermost region, since the fire is most active, it might easily consume air and everything else, and since it is bright, from its own nature it could be easily seen by us, but [as] it would have no further [fuel] it will easily be extinguished in the uppermost region, just as a lantern is extinguished when its oil runs out.

But with common philosophy it is responded that it cannot be denied that the region of the fire is above air, for although it cannot be seen by the eye, nevertheless reason and experience suggest thus, just as no one sees air, but whether it exists or not, no one doubts. Indeed this is proven firstly because heat is the most perfect of all the four qualities, and it is not found in another element in its own perfection, whether in air, or in earth, or in water. Therefore there is the fourth element of fire, which would be the hottest, driest, and lightest of all. This is confirmed since it would be most fitting for the perfection of the universe, that just as the coldest element is given, so another hottest one should be given. And next, to each and every element its own locus is assigned by nature, so that while it is in its own place, it would be absolutely at rest; and while it is outside its locus, it is violent and is restless in a certain way; but although our usual fire, namely flame, is brighter than air due to the admixture of vapors, nonetheless it always ascends upward, and never descends or rests. Therefore its own, natural locus is not earth, but above air. This argument from sign is the best, since as anyone might well infer, all streams naturally run down into some part, thus that is where the greatest gathering of waters is and their own natural locus, so also every fire naturally ascends upward, therefore that is where its natural locus is, etc.

Est igitur iuxta lunam elementum ignis,<sup>1</sup> positum supra aerem, rarissimum, maxime calidum, et siccum. Habent etiam elementa eam propositionem, sicut philosophi dicunt<sup>2</sup>, ut ut quanto aqua rarior est terra, tanto aer rarior sit aqua, et verus elementalis ignis tanto etiam subtilior sit<sup>3</sup> aere; sicut enim siccitas cum frigiditate maxime ad gravitatem conducunt, ita etiam summus calor cum<sup>4</sup> siccitate maximam levitatem et raritatem causat. Hinc colligitur elementalem ignem ideo aerem propinquum totum non consumere, quia cum maxime rarus sit, non habet tamen vim et activitatem, quantum si densus esset, sicut patet ex exemplo; [f.21v.] flamma enim licet verus sit ignis, non tamen adeo efficax est ac<sup>5</sup> ac<sup>5</sup> ferrum candens propter sui raritatem; cum ergo aer densior sit igne eique sua humiditate resistat, non facile absumitur, nec aer adeo apta materia est, ut in eo ignis per multum temporis conservetur.

Secundo colligitur hunc ignem elementalem propter suam maximam<sup>6</sup> raritatem non lucere; noster enim ignis ideo lucet, quia crassior et plenus vaporibus accensus est, sicut etiam radii solares in speculo multiplicati multo magis lucent quam in aere recepti.

Tertio colligitur ignem usuaem vere ignem esse, admixtum tamen vaporibus vel alio corpore, sicut in flamma et pruna<sup>7</sup> patet, qui ideo nutritione indiget, ut contrariis possit obsistere qualitatibus, frigori scilicet et humiditati, tum etiam quia materia, in qua recipitur, pruna scilicet et vapores inflammati, maxime fluxibilis et corruptibilis est. Ergo etiam nutritione indiget, ut extra locum suum violenter conservari possit: in propria autem sphaera nutrimento non indiget, sicut nec alia elementa, quia ibi nec actione contrariorum torquetur, nec extra locum suum violentus detinetur.

Est autem addendum plura esse genera ignium, seu plures modos producendi ignem. Primo est artificialis ignis, qui ex rebus maxime calidis et siccis fit, et pulvis dicitur tormentarius: hic in bombardam apposito igne, cum sit maxime dispositus, facillime accenditur; et ut rarefiat, ignis accensus magno impetu prosilit et<sup>8</sup> strepitum facit. Raritas enim proprium accidens ignis est.

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<sup>1</sup> Ms. ...elementum ~~eorum~~ ignis Obara ...elementum verum ignis.

<sup>2</sup> Arist. *Cael.* 287b20.

<sup>3</sup> Ms. sit Obara fit.

<sup>4</sup> Correxist Obara ex sicum [si cum?].

<sup>5</sup> Correximus ex ideo efficax est ad.

<sup>6</sup> Ms. ...suam ~~magnitud~~ maximã.

<sup>7</sup> Correxist Obara ex pluna.

<sup>8</sup> Sic Ms. Obara atque.



Therefore, next to the moon the element of fire exists, placed above air, the thinnest, hottest, and driest. Elements furthermore have the following proposition, just as philosophers say, namely that to the degree that water is thinner than earth, to the same degree air is thinner than water, and true elemental fire is also subtler than air to the same degree; for just as dryness with coldness is most conducive to heaviness, so also the greatest heat with dryness causes the greatest lightness and thinness. Hence it is inferred that elemental fire does not consume neighboring air in its entirety due to the fact that since it is most thin, it nonetheless does not have force and activity to the degree it would have if it were dense, just as an example demonstrates; [f.21v.] for although flame is true fire, nonetheless it is not as effective as glowing iron due to its own thinness. Therefore, since air is denser than fire and resists it by its own humidity, it is not easily consumed, and air is not such an apt matter for fire to be conserved in it for much time.

Secondly, it is surmised that this elemental fire does not shine due to its greatest thinness; for our fire shines for this reason, namely that it is thicker and is full of burning vapors, just as solar rays, when multiplied by a mirror, shine much more than when they are received in air.

Thirdly, it is surmised that the usual fire is truly fire, with the admixture, however, of vapors or of another body, just as is evident in flame and burning coal, and for this reason this fire requires nutrition for it to resist contrary qualities, namely coldness and humidity, and also because the matter, in which it is received, namely glowing coal and inflamed vapors, is very much subject to flux and is corruptible. Therefore it also needs nutrition in order to be violently conserved outside its own locus. In its own sphere, however, it has no need of nutriment, just as other elements do not, since it is not twisted by the action of the contraries, nor is it violently detained outside its own locus.

It must be added that there are several kinds of fires, or several ways of producing fire. First there is the artificial fire, which is made from things most hot and dry, and is called cannon powder. This, when fire is placed next to it in a cannon, as it is most fittingly arranged, is kindled most easily; and so that it may become thin, the lighted fire jumps out with a great impetus and it makes a noise. For thinness is the proper accident of fire.

Alius ignis subterraneus est; nec de igne inferni modo loquimur, sed de eo, qui in vulcanis reperitur, de quo cum iam de terra<sup>1</sup> egerimus, loquemur; enim communiter in insulis et locis maritimis ob multitudinem exhalationum ignitarum solet produci.

Ignis etiam aliquando producit a radiis solaribus reperiuntur in speculo, non quia ipse sol in se ignitus aut calidus sit, sed quia media luce tamquam instrumento habet virtutem activam: unde materia illa manet disposita ad hoc, ut formam et<sup>2</sup> naturam ignis possit recipere a virtute solis productam; nec mirum, sol enim virtutem habet producendi viventia, ut statim dicemus; quanto magis non viventia? Aliquando etiam ex collisione duorum corporum, ut duorum lapidum, aut etiam silicis cum chalybe, non quia in lapide aut in ferro, aut etiam in aere interiecto formaliter sit ignis, sed quia ex dicta collisione taliter disponitur aer, ut [f.22r] aptus sit recipere formam ignis. Motus enim est causa caloris, ut tenet communis philosophorum sententia, et per illam vehementem collisionem silicis cum chalybe vehementer aer interpositus calefit, simulque rarefit aer interceptus; cui etiam accedit, ut per illam percussionem exhalatio aliqua ex lapide educatur, quae apta est, ut accendatur, atque ideo<sup>3</sup> ibi, cum materia sit disposita, ignis resultat,<sup>4</sup> accidentiaque illa, calor, raritas, et exhalatio lapidis habent se per modum dispositionis aut seminis ad productionem ignis; nec mirum, calor enim ignis vapores, qui in ligno inclusi sunt, facit exhalare, eiusque virtute disponuntur, ut facile naturam aeris aut venti possint recipere.

### § 3.<sup>5</sup>

#### De loco et figura<sup>6</sup> elementorum

Unicuique autem elementorum sicut propriam Deus assignavit naturam, ita etiam sibi convenientem sedem et locum destinavit, in quo naturaliter conquireret, ita ut terra, quae ob frigiditatem et siccitatem gravior est, infimum locum teneret; huic proximum aqua, quae etiam ob frigiditatem et humiditatem gravis est; tertius aeri debetur, quia levior utpote calidus et humidus est; supremus vero igni,<sup>7</sup> qui omnium est levissimus. Quod ita intelligendum non est, ut certum spatium universi semper occupet aer, aliud aqua etc., sine eo quod possit mutare locum,

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<sup>1</sup> *Coniecimus ex Ms.* ...de quo iã de terra, *Obara* ...de quo iam [quando?] de terra.

<sup>2</sup> *Sic Ms.*, *Obara* seu.

<sup>3</sup> *Correximus ex Ms.* *Obara* adeo.

<sup>4</sup> *Correxit Obara ex Ms.* resurtat.

<sup>5</sup> *Ms.* §, *Obara* § 2., *inseruimus* 3.

<sup>6</sup> *Correxit Obara ex* et in figura.

<sup>7</sup> *Ms.* igni.

Another fire is the subterranean one. And we are not speaking now about the fire of hell, but of that one, which is found in volcanos, of which we will speak when we have already discussed earth; for it is commonly accustomed to be produced on islands and in maritime locations due to the multitude of fiery exhalations.

Fire furthermore is sometimes produced from solar rays reflected in a mirror, not because the sun on its own is fiery or hot, but because it has an active virtue by means of the medium of light just as by means of an instrument; whence that matter remains well arranged for this end, namely so that it may receive the form and nature of fire produced by the virtue of the sun; nor is this strange, for the sun has the virtue of producing living matters, as we shall immediately say. How much more [does it have the virtue of producing] things non-living? Sometimes also [fire is produced] from the collision of two bodies, as of two stones, or even of a flintstone and steel, not because fire exists formally in the stone or in the iron, or even in the intervening air, but because from the said collision air is disposed in such a way [f.22r] that it becomes fit to receive the form of fire. For motion is the cause of heat, as the common opinion of philosophers holds, and through that vehement collision of flintstone with steel the interposed air is vehemently heated, and at the same time the intercepted air becomes thin; to which also the following is added, namely that through that percussion some kind of exhalation is brought out from the stone, which is suitable to be kindled, and for this reason in that place, when the matter is well disposed, a fire results. And those accidents, [that is to say] heat, thinness, and the exhalation of the stone are configured through their mode of disposition or of the seed for the production of fire; nor is this strange, for the heat of the fire makes the vapors, which are shut inside the wood, to breathe forth, and by its virtue they are disposed in such a manner that they can easily receive the nature of air or of wind.

### § 3.

#### **On the place and shape of elements**

Just as God assigned to each of the elements its own nature, so He destined a seat and place fit for them, in which they might naturally rest, so that earth, which on account of its coldness and dryness is heavier, might hold the lowest place. Next to it water [might hold its place], which is also heavy due to its coldness and humidity. The third place is given to air, since it is lighter, inasmuch as it is hot and wet; the highest place, however, [is given] to fire, which is the lightest of them all. This is not to be thus understood, that air should always occupy a certain space of the universe, and water another, etc., without the possibility of one [element] changing its place,

et aut inferius descendere aut superius ascendere;<sup>1</sup> sed quod terra naturaliter infimam universi partem appetit pro suo loco, ita ut, si extra eum fuerit, sit quodammodo violentata; aeri etiam repugnet non esse in loco aquae aut terrae, sed esse sub aqua aut terra; et igni etiam puro esse sub aere omnino repugnet. Quem ordinem omnino servant elementa; unicuique enim<sup>2</sup> indidit Deus naturalem propensionem et vim, ut si extra locum suum sint, naturaliter ad eum moveantur, et dum in loco suo sunt, nullam habent virtutem motivam, nisi ab alio moveantur. Verum est tamen quod, cum elementa sint partes universi, aliquando locum suum deserentes ascendunt vel descendunt contra propriam naturam et extra suum locum conservantur, ne detur vacuum in natura, sicut patet in clepsydra,<sup>3</sup> aut etiam in alio vase, cuius orificium angustum est. Aqua enim ibi inclusa non descendit, quia locus non est, ut aer ingrediatur, et ne detur vacuum in natura, ipsa descendere non potest. Sed in particulari, quem locum habent elementa respectu universi, respondetur et sit prima conclusio: Terrae locus naturalis est in [f.22v.] centro terrae, ut<sup>4</sup> usque ad caelorum circumferentiam lineae deductae in partem omnem sint aequales. Hoc est maximum miraculum in natura, ut terra ipsa, cum maximae sit molis, ad oculus nostrum quasi in aere posita sit;<sup>5</sup> sed quod sit terra in medio mundi, probatur multis rationibus.

Prima desumitur ex eclipsi lunari; ut enim diximus, eclipsis lunaris est<sup>6</sup> interpositio terrae inter solem et lunam, sed si terra non esset in medio universi, sed in unam partem vel ad alteram declinaret, evidenter sequeretur eclipsim lunae nullo modo posse contingere in puncto oppositionis, quando luna differt oppositione per medium mundi, quod etiam experientia falsum est; semper enim eclipsis in puncto oppositionis fit, ut patet in figura [Fig. 1]; est ergo terra in medio universi.

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<sup>1</sup> *Inseruimus* aut superius ascendere.

<sup>2</sup> *Ms.* enī, *Obara* eorum.

<sup>3</sup> *Ms.* clepsida, *Obara* clepsidra.

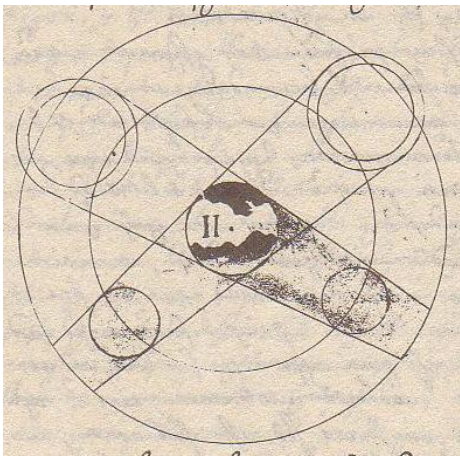
<sup>4</sup> *Inseruimus.*

<sup>5</sup> *Coniecimus ex Ms.* ...in aëre posita. *Obara* ...in aere [sit] posita.

<sup>6</sup> *Inseruit Obara.*

and either descending lower or ascending higher; but that earth naturally seeks out the lowest part of the universe as its own place, so that, if it were to be outside this place, it would be made violent in some way. It would also be repugnant to air not to be in the place of water or earth, but to be under water or earth. It would also be repugnant overall to pure fire to be under air. The elements keep this order overall, for to each God attributed a natural propensity and force, so that if they were to be outside their own place, they would naturally move to it, and while they are in their own place, they have no motive strength, unless they be moved by something else. It is nonetheless true that, as elements are parts of the universe, sometimes, deserting their own place, they ascend or descend against their own nature and are conserved outside their own place, lest there be vacuum in nature, just as is evident in a water clock, or even in another vessel, whose opening is narrow. For water enclosed therein does not descend, because there is no place for air to enter, and so that vacuum should not exist in nature, [water] itself cannot descend. But in particular, as to what place elements hold in respect to the universe, it is answered and let this be the first conclusion: The natural place for earth is in [f.22v.] the center of the earth, such that lines drawn toward the circumference of the heavens should be equal in all directions. This is the greatest miracle in nature, that earth itself, though it is of the greatest mass, should be placed, as it were, in air as far as our eyes are concerned. But that earth is in the middle of the world is proved by many reasons.

The first [reason] is taken from the lunar eclipse, for as we have said, the lunar eclipse is the interposition of earth between the sun and the moon, but if earth were not in the middle of the universe, but were inclined into one part or towards another, it would evidently follow that the eclipse of the moon could by no means happen at the point of opposition, when the moon diverges in opposition [to the sun] through the middle of the world. This is also false by experience, for the eclipse always happens at the point of opposition, as is evident in the figure; thus earth is in the middle of the universe.



**Fig. 1**

Quod si quis dicat terram non esse in medio mundi, sed ad latus declinare; ita tamen posita est, ut in tempore oppositionis solis cum luna, terra interposita maneat in medio eorum, non quidem in medio mundi, sed ad latus, soli lunaeque magis appropinquans;

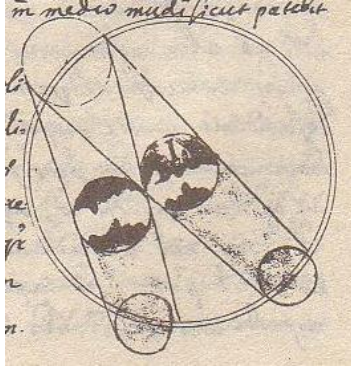


Fig. 2

contra hoc est secunda ratio, quia eclipsis lunae non fit semper eodem signo Zodiaci, sed in diversis; semper enim mutatur locus eclipsis atque ideo,<sup>1</sup> si terra non esset in medio mundi, aliquando<sup>2</sup> eclipsis fieret in oppositione, aliquando extra eam; sed sic est, quod eclipsis numquam fit, nisi quando luna distat a sole per medium<sup>3</sup> aequaliter, ergo terra debet esse in medio mundi, sicut patebit in figura. [Fig. 2]

Tertia quia si terra non esset in medio, aliquae caeli partes deberent nobis esse propinquiores, aliquae vero distantiores; unde stellae existentes in propinquiori parte maiores aliis apparent, quod experientia falsum est. Deinde quia alias non possemus videre semper mediam partem caeli, nec mediam partem signorum; si enim [f.23r.] terra esset infra centrum mundi, maior medietate signorum appareret, si supra centrum, minor medietate, si ad aliquam partem declinaret, illa pars, cui appropinquaverit, magis occultabitur; sed sic est, quod media semper signorum pars apparet; est ergo terra in medio mundi. Deinde cum terra sit omnium gravissima, si ab omnibus caeli partibus proiceretur, necessario deberet descendere in locum omnium infimum, qui scilicet aequaliter distaret<sup>4</sup> ab omnibus caeli partibus; hic ergo locus est, quem nunc tenet, centrum scilicet et medium mundi. Item<sup>5</sup> etiam probant rationes, quibus probabimus terram esse rotundam.

Secunda conclusio: Terra sic in medio existens est velut<sup>6</sup> punctus respectu firmamenti; firmamenti; probatur primo, quia sol, ut diximus, multo maior est terra, et tamen a terra in minima apparet quantitate, terra ergo respectu caeli solis minimae erit magnitudinis, quod si octavae sphaerae seu firmamento comparatur, erit veluti punctum. Secundo quia si alicuius magnitudinis esset terra<sup>7</sup> respectu firmamenti, non posset nobis media pars caeli<sup>8</sup> semper apparere propter terrae tumorem; nunc autem quia minima est maximeque distans a firmamento, eius tumor seu rotunditas impedire non potest, quin media semper pars firmamenti nobis appareat, mediaque occultetur, sicut superius diximus tractatu primo capite tertio.

<sup>1</sup> *Correximus ex adeo.*

<sup>2</sup> *Ms. aliquo alio.*

<sup>3</sup> *Omisimus sole.*

<sup>4</sup> *Correximus ex disparet.*

<sup>5</sup> *Sic Ms., Obara Idem.*

<sup>6</sup> *Correxit Obara ex velud.*

<sup>7</sup> *Ms. ...alicuius terra Obara ...alicuius [quantitatis esset] terra, fortasse recte.*

<sup>8</sup> *Omisimus nobis.*

But if someone should say that earth is not in the middle of the world, but is inclined towards its side; nonetheless it is so positioned, that in the time of the opposition of the sun with the moon, earth remains interposed in their middle, not to be sure in the middle of the world, but to its side, and coming closer to the sun and the moon. Against this there is the second reason, namely that the eclipse of the moon does not always happen in the same sign of the zodiac, but in different ones; for the place of the eclipse always changes and for this reason, if earth were not in the middle of the world, the eclipse would sometimes happen in the opposition, sometimes outside it. But it happens thus, that the eclipse never takes place, unless when the moon is distant from the sun through the middle in equal measure, thus earth ought to be in the middle of the world, just as is evident in the figure.

The third [reason is] that if earth were not in the middle, some parts of heaven should have been closer to us, but some more distant; whence stars existing in the closer part would appear larger than the others, which is false by experience. And then, since otherwise we would not always be able to see half of heaven, nor half of the constellations; for if [f.23r.] earth were beneath the center of the world, a greater part than half of the constellation should be visible, if it were above the center, a smaller part than half, if it were inclined toward some part, that part, to which it should come close, will be more hidden. But it is thus, that always half of the constellations appear. Earth therefore is in the middle of the world. And then, since earth is the heaviest of all, if it should be thrown forth from all parts of the sky, by necessity it should descend into the lowest place of all, which would namely be equally distant from all parts of heaven. This therefore is the place that it now holds, namely the center and middle of the world. The reasons, by which we will prove that earth is round, prove likewise.

The second conclusion: Earth thus existing in the middle is just like a point with respect to the firmament. This is first proven since the sun, as we have said, is much greater than earth, and yet it appears from earth in minimal quantity, therefore earth will be of minimal size with respect to the heaven of the sun, but if it is compared to the eighth sphere or the firmament, it will be just like a point. Secondly, since if earth were of some size with respect to the firmament, half of heaven could not always appear to us due to the bulge of earth. Now, since it is very small and most distant from the firmament, its bulge or rotundity cannot impede half of the firmament from always appearing to us, and half of it from being hidden, just as we said above in the first treatise in the third chapter.

Tertia conclusio: Terra in medio existens immobilis est; probatur quia si posset moveri, moveretur vel motu<sup>1</sup> recto vel circulari, sed neutro horum modorum moveri potest. Non recto, quia tunc vel moveretur ab alio, vel a semetipsa; non a sepetipsa, quia cum terra gravissima sit, semper centrum appetit; quod si in<sup>2</sup> aliquam partem declinaret, iam non descenderet in locum suum, sed potius ascenderet versus caelum contra propriam naturam; nec etiam dici poterit, quod ab alio impellatur; hoc erit mere ficticium, quae enim vis<sup>3</sup> erit potens violenter impellere<sup>4</sup> tantam machinam? Nec etiam circulariter moveri potest, ut probavimus in primo tractatu capite secundo, tum ob maximam eius molem, tum etiam quia, si 24 horarum spatio unam circulationem deberet conficere, sicut moventur caeli, velocissime deberet rapi ita, ut passeret eam insequi non possent, quod ridiculum est; quod si quis dicat, qui fieri potest,<sup>5</sup> ut si vere antipodae sunt, id est inhabitantes partem contrariam nostro hemisphaerio, non cadant versus caelum, respondemus, quod cum terra sit centrum mundi, si versus omnem<sup>6</sup> partem caeli comparetur, infimum tenet locum; omne omne autem grave naturaliter tendit deorsum; unde si inhabitantes partem nobis contrariam moverentur versus caelum, non iam cadere, sed potius ascendere [f.23v.] dicerentur, quia non in infimam mundi partem moverentur, sed potius in altiore ascendere, scilicet in caelum. Unde fit ut, si verbi gratia puteus esset ab hac parte in partem mundi nobis contrariam transiens per medium centrum et lapis proiceretur ab isto loco, motu suo naturali<sup>7</sup> descenderet usque in centrum, deinde etiam propter impetum seu impulsum, quem recepit in partem contrariam, etiam ascendet aliquantulum violenter, sed statim suo motu naturali deficiente impulsu revertetur in<sup>8</sup> centrum.

Ex his patet, quis sit locus naturalis aliorum elementorum. Si enim terra centrum mundi possidet, aqua secundum ordinem naturae supra terram esse debet; deinde aer aquam circumire; ignis vero aerem circumiens supremum locum iuxta concavum lunae possidebit. Sed de aqua specialis est difficultas pro hoc statu, de quo paragrapho sequenti dicemus.

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<sup>1</sup> Ms. ~~prop.~~

<sup>2</sup> Inseruit Obara.

<sup>3</sup> Correxuit Obara ex vix.

<sup>4</sup> Correxuit Obara ex impeleret.

<sup>5</sup> Ms. quâ fieri potest Obara quin fieri queat.

<sup>6</sup> Omisimus mundi.

<sup>7</sup> Correximus ex Ms. caeli Obara caeli. Vide paulo infra.

<sup>8</sup> Ms. in ~~ad~~ Obara in (iterum?) ad.



The third conclusion: Earth existing in the middle is immobile. This is proven since if it could move, it would move either in a straight or circular motion, but it cannot move in either of these ways. Not straight, since then it would either be moved by something else, or by itself. Not by itself, since as earth is the heaviest, it always seeks the center. But if it should incline towards some part, it would no longer descend into its own place, but would rather ascend toward heaven against its own nature. Nor can it be said that it is pushed by another thing. This will be mere fiction, for what force will be able to violently push such a great mechanism? Nor can it furthermore move in a circular manner, as we proved in the first treatise in the second chapter, both on account of its greatest mass, and because, if it were necessary to complete one circle in the space of 24 hours, just as the heavens move, it would be necessary to be snatched away with such extreme speed that sparrows would not be able to follow it, which is ridiculous. But if someone should say, “how can it be, if there are in truth antipodes, that is to say those inhabiting the part opposite to our hemisphere, that they would not fall toward heaven?” We shall respond that since earth is the center of the world, if it should be compared to every part of the heavens, it holds the lowest place; every heavy thing naturally tends downward; whence, if those inhabiting the part contrary to ours should move toward heaven, they would no longer be said to be falling, but rather to be [f.23v.] ascending, since they would be moving not into the lowest part of the world, but would rather be ascending to a higher part, namely into heaven. Whence it happens that, if for example there were a well going across from this part to the part of the world opposite to ours through the center in the middle and if a stone should be thrown forth from this place, by its natural motion it would descend all the way to the center, then furthermore, on account of the impetus or impulse, which it received in the opposite direction, it will also rise violently to some extent, but by its natural motion, with the impulse ceasing, it will immediately return toward the center.

From these, what the natural place of the other elements is, becomes evident. For if earth possesses the center of the world, water according to the order of nature ought to be above earth; then air ought to surround water; fire, however, surrounding the air, will possess the highest place next to the concave [surface] of the moon. But concerning water there is a special difficulty as to this state, on which we shall speak in the following paragraph.

§4.<sup>1</sup>**De figura elementorum**

Egimus de loco; nunc de quantitate et figura elementorum, et incipientes a terra sit prima conclusio: Terra figuram habet sphaericam, non planam. Probatur primo, quia si terra esset plana aut quadrata, et non sphaerica, aequali et eodem tempore sol, luna et omnes caeli partes omnibus nationibus orirentur et occiderent, sed experientia constat non ita contingere, immo singulis horis 15 gradus equinoctialis paulatim supra horizontem oriuntur et totidem occidunt, ita ut, quo aliqua regio orientalis est, eo citius stellae, sol et luna exoriantur quam aliis, quod in eclipsi lunari evidenter cognoscitur; si enim verbi gratia eclipsis lunaris hic observatur<sup>2</sup> in puncto mediae noctis, in regione, quae magis orientalis est respectu nostri, observabitur hora prima vel secunda vel tertia post mediam noctem etc.; illis,<sup>3</sup> qui nobis ad occidentem adiacent, apparebit una duabus vel tribus horis ante mediam noctem; quod nullatenus contingeret, si terra esset plana et non sphaerica, ut patebit in figura. [Fig. 3]

Deinde experientia constat, quod existentes in parte septentrionali vident plures stellas in septentrione quam nos, sed plures etiam stellae versus austrum sibi occultantur, ita ut verbi gratia si quis haberet altitudinem poli 40 graduum, alter polus sibi occultabitur per totidem gradus; quod si is versus meridiem [f.24r.] iter faciat, paulatim polus, qui ei semper apparebat, occultabitur, et polus, quem numquam viderat, paulatim sibi apparebit; hoc autem fieri non posset, nisi terra esset rotunda.

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<sup>1</sup> Ms. §, Obara § 3., inseruimus 4.

<sup>2</sup> Sic Ms., Obara observetur.

<sup>3</sup> Correximus ex illi.

## §4.

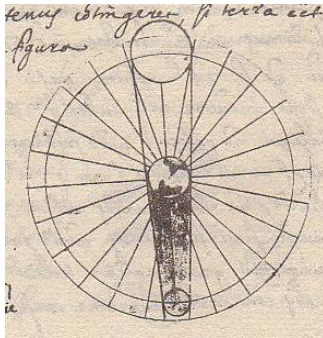
**On the shape of the elements**

Fig. 3

We have discussed the place; now [we shall discuss] the quantity and shape of the elements, and beginning with earth let this be the first conclusion: Earth has a spherical, not flat, shape. This is first proven, since if earth were flat or square, and not spherical, the sun, the moon and all other parts of heaven would rise and fall for all nations at equal and identical time. But it is confirmed by experience that it does not happen thus, but rather at every hour they slowly rise 15 equinoctial degrees above the horizon and fall by the same number, so that, to the degree that some region is more to the east, by that much the stars, the sun and the moon rise earlier than to others. This is evidently learned in the lunar eclipse; for if for example the lunar eclipse is observed here at the point of midnight, in a region, which is more eastward in respect to us, it will be observed at the first or second or third hour after midnight etc.; and to those, who lie to the west next to us it will appear one, two or three hours before midnight. This would by no means happen, if earth were flat and not spherical, as will be evident in the figure.

Then it is agreed by experience, that those who are in a northern region see more stars in the north than us, but also more stars to the south are hidden to them, so that for example if anyone should have the polar height of 40 degrees, the other pole will be hidden to him by the same degrees; but if he should travel [f.24r.] towards the south, the pole, which always appeared to him, will be hidden little by little, and the pole, which he had never seen, will appear slowly. This, however, could not happen, unless the earth were round.

Secundo probatur idem, quia cum terrae umbra sit, quae lunam eclipsat, qualis fuerit figura corporis<sup>1</sup>, talis necessario erit umbrae figura, sed umbra terrae semper apparet rotunda in eclipsi,<sup>2</sup> praecipue lunae partiali, quando scilicet media pars lunae eclipsatur; partes enim lunae non eclipsatae corniculares apparent et eclipsata pars circuli habet figuram; erit ergo terra ipsa in se rotunda. Si enim<sup>3</sup> figuram angularem haberet, angularis etiam umbra in luna deberet apparere. Quod si quis dicat: Verum est terram non esse omnino planam, non tamen probant argumenta esse omnino sphaericam, poterit enim esse lenticularem figuram seu ovi figuram habere; sed contra hoc est<sup>4</sup> experientia, si enim quis verbi gratia sub aequinoctiali degens directe versus polum 10 et 7 cum dimidiata leucas<sup>5</sup> confecerit vel 62 miliaria, quod idem est, inveniet polum uno gradu supra horizontem elevari, et quoties id fecerit, semper unus gradus accrescet quousque directe sub polo sit; hoc autem fieri non posset, si terra ovi figuram haberet non sphaericam. Tunc enim gradus, qui sunt versus polum, plures leucas haberent, qui vero versus aequinoctialem pauciores, ut in figuris patet. [Fig. 4]

Est tamen advertendum terram non esse perfecte sphaericam, sicut est globus ad manum factus;<sup>6</sup> sunt enim altissima montium cacumina et valles profundissimae; quia tamen hoc respectu tantae molis, qualem habet terra, prope nullius momenti est, ideo tota terra sphaerica et rotunda dicitur lato modo, sicut globus lapideus, licet foramina multa habeat, rotundam tamen habere dicitur figuram. Ratio autem quare<sup>7</sup> ad oculos terra plana esse iudicatur, est propter eius magnitudinem, sicut si quis maximi circuli aliquam partem minimam conspiceret, eam non circuli, sed lineae rectae partem iudicaret. [f.24v.]

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<sup>1</sup> *Omisit Obara* corporis.

<sup>2</sup> *Sic Ms., Obara* eclipse.

<sup>3</sup> *Sic Ms., Obara* vero.

<sup>4</sup> *Sic Ms., Obara* adest.

<sup>5</sup> *Ms. #leucas.*

<sup>6</sup> *Ms. factus#.*

<sup>7</sup> *Sic Ms., Obara* quacum.

Secondly, the same is proven since, as the shadow of earth is what eclipses the moon, the kind of shape a body has, such would necessarily be the shape of the shadow, but the shadow of earth always appear round in the eclipse, especially of the partial lunar kind, when namely half of the moon is eclipsed. For the parts of the moon not eclipsed appear horn-shaped, and the eclipsed part has the shape of a circle. Therefore earth itself is round in itself. For if it had an angular shape, the shadow in the moon also should appear angular. But if someone should say: It is true that earth is not flat overall, the arguments nonetheless do not prove that it is spherical overall, for it can have a lenticular shape or the shape of an egg. But against this there is the experience, for if someone for example living under the equinoctial line should go directly toward the pole for 17 and a half *leuca* or 62 *miliaria*,

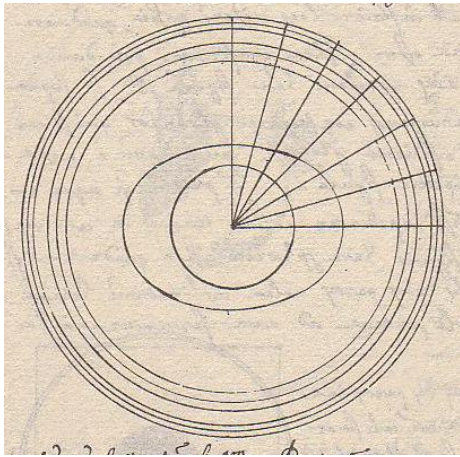


Fig. 4

which are the same, he will find the pole to be elevated by one degree above horizon, and as often as he should do this, always one degree will be added all the way until he should come directly under the pole. This, however, could not happen, if earth had the shape of an egg, not a spherical one. For then the degrees, which are towards the pole, would have more *leuca*, those, however, towards the equinoctial line would have fewer *leuca*, as is evident in the figures.

It must be noted nonetheless that earth is not perfectly spherical, just like a hand-held globe; for there are very high peaks of mountains and very deep valleys; since, however, this is of

almost no account in respect to such a great mass, of the kind that the earth has, for this reason earth in its entirety is called round and spherical in a wide sense, just like a stone ball, even though it may have many holes, is said to have a round shape. The reason, however, why earth is judged flat by the eye is on account of its magnitude, just as if someone should see some very small part of a very large circle, he would judge that part to be not of a circle, but of a straight line. [f.24v.]

Secunda conclusio: Aqua etiam habet figuram sphaericam unumque cum terra globum constituit.<sup>1</sup> Pro quo notandum,<sup>2</sup> quod Deus in principio, ut colligimus ex primo capite Genesis, terram omnino sphaericam iuxta centrum construxit; aquam vero fecit, ut totam ambiret terram, verum propter habitationem animantium et praecipue propter hominem iussu Dei aquae omnes congregatae sunt in locum unum, terraque apparet arida, congregationesque aquarum vocavit Deus maria.<sup>3</sup> Hoc autem ita factum fuisse Divus Ioannes Damascenus asserit ex maiorum traditione, ut terra Dei imperio oboediens in innumeras concavitates profundissimas scinderetur et aquae intra illas receptae diversa conficerent maria, terra autem sic divisa maneret in insulas innumeras et terram continentem, terrae autem praescisae et disruptae partes in montes altissimos elevarentur, immo et terra intra suas concavitates magnam aquarum copiam includeret, ex quibus factum est, ut aqua unum globum cum terra conficeret.<sup>4</sup> Quod autem aqua rotundam habeat figuram, probatur primo communi illa experientia: Navi enim a portu discedente post aliquam distantiam turris altissima in litore existens a pede mali conspici nullatenus potest, cum tamen a summitate mali facillime conspiciatur; cuius causa est, quia tumor seu

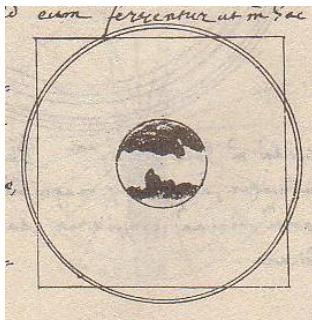


Fig. 5

rotunditas aquae impedit, ne ab inferiori loco videri possit, quod non contingeret, si aqua plana esset. Hoc confirmari potest: Dum enim aqua effunditur, guttulae eius rotundam habent figuram; et si supra pulverem proiciatur, innumeros conficeret globulos, qui si coniungantur unum maiorem efficient globum, quod signum est aquam ex natura sua rotundam expetere figuram. Secundo probatur, quia aqua ex natura sua gravis est et, nisi impediatur, naturaliter tendit in centrum; debet ergo ex natura sua figuram habere sphaericam; si enim quadratam verbi gratia figuram haberet, iam non omnes eius partes naturalem inclinationem haberent ad centrum, neque aequali pondere ad eum ferrentur, ut in hac figura patebit [Fig. 5], in qua quadratum sit aqua, cuius omnes partes inaequaliter a centro distant, circa quam<sup>5</sup> tale fit argumentum: Aqua naturaliter, cum cum sit fluida, descendit in centrum; si ergo quadrata sit, quomodo partes aquae, quae in angulis<sup>6</sup> sunt, non defluunt in partes inferiores, quae minus a centro distant, sicut in rivulis contingit [f.25r.], in quibus, quia aqua locum invenit declivorem,<sup>7</sup> continuo descendit?

<sup>1</sup> *Correxit Obara ex* constitui.

<sup>2</sup> *Sic Ms., Obara* notandum est.

<sup>3</sup> OT *Gn.* 1.9-10.

<sup>4</sup> Ioannes Damascenus *De Fide Orthodoxa* 2.9.

<sup>5</sup> *Sic Ms., Obara* quem.

<sup>6</sup> *Ms.* in #angulis.

<sup>7</sup> *Ms.* decli\vi/ore'.

The second conclusion: Water also has a spherical shape, and constitutes one globe together with earth. On which it must be noted, that God in the beginning, as we gather from the first chapter of the Genesis, constructed earth spherically overall next to the center. He made water, so that it would surround earth in its entirety, but on account of the habitation of animals and especially on account of man, all waters by the command of God were gathered into one place, and dry land appears, and God called the gatherings of waters seas. St. John of Damascus, based on the tradition of the elders, asserts that this happened thus, namely that earth, obeying God's command, was split into innumerable and very deep concavities, and waters received therein made diverse seas, and earth on the other hand remained thus divided into innumerable islands and a continental land, and sharp and broken parts of earth on the other hand were elevated into the highest mountains, and indeed earth also kept a great amount of waters within its own concavities, from all of which it came to be, that water made up one globe with earth. As for the fact that water has a round figure, this is proven first by that common experience. For when a ship leaves port, after some distance a very high tower standing on the shore can by no means be seen from the base of the mast, though nonetheless it is seen very easily from the top of the mast. The reason for this is that the bulge or rotundity of water keeps it from being seen from a lower place, which would not happen, if water were flat. This can be confirmed, for while water is being poured out, its drops have a round shape; and if it is thrown above dust, it would make up innumerable globules, which if joined together will make a greater globe, which is a sign that water by its own nature seeks out a round shape. This is proved secondly, since water is heavy by its own nature and, unless it is impeded, it naturally tends toward the center. Therefore it ought by its own nature to have a spherical shape; for if it had a square shape for example, then not all of its parts would have a natural inclination towards the center, nor would it be carried to it with equal weight, as is evident in this figure, in which water is a square, whose parts are all unequally distant from the center, on which an argument such as this is made: Water, as it is fluid, naturally descends into the center; if therefore it should be square, how could the parts of water, which are in the angles, not flow downward into the lower places, which are less distant from the center, just as happens in rivulets, [f.25r.] in which, since water finds a more downward place, it goes down continually?

Quod vero terra et aqua unum constituunt globum, ita ut mare non sit altius terra, patet rationibus adductis pro rotunditate terrae. Eaedem enim experientiae probant terram esse rotundam et aquam. Primo probatur, quia navigantes 10 et 7 leucas cum dimidiata semper unum gradum conficiunt, sicut de iter agentibus diximus. Secundo, quia ubique innumerae insulae reperiuntur in medio maris, quod contingere non posset, si mare esset multo altius terra. Tertio, quia esset maximum et perpetuum miraculum, quod mare, si altius est terra, non defluat in inferiorem partem totamque terram inundet. Quarto, quia nave accedente ad portum prius cacumina montium apparent, deinde paulatim magis ac magis montes ipsi videntur, quod fieri non potest, si mare multo altius esset terra. Tunc enim clare tota terra appareret etiam a longe sicut, qui ascendit supra montem altum, unico ictu<sup>1</sup> oculi totam inferiorem conspicit terram. [Fig. 6] Quinto,<sup>2</sup> quia umbra terrae sola non eclipsat lunam, sed umbra utriusque elementi, scilicet aquae et terrae. Haec autem umbra rotunda est, ut diximus; aqua ergo et terra unicum globum constituunt.

Ex his patet primo antipodas esse in mundo. Longa enim navigatione compertum est omnem prope mundi plagam inhabitari, contigitque non semel navim ab uno portu exire, quae cum semper ad occidentem navigaret, post multum temporis spatium ad eundemmet rediit portum; ex quo experientia constitit id, quod ratio naturalis dictabat, vere in toto mundo esse antipodas.

Secundo patet terram ob maiorem sui gravitatem centrum possidere, aquam vero supra ipsam terram ferri, ita ut maris profunditas communiter unam vel duas leucas non videatur excedere. Ubique enim etiam in medio pelagi innumerae insulae et scopuli reperiuntur, quod [f.25v.] indicat terram sub mare non esse nimis profundam.

Tertio patet, quae sit magnitudo terrae et aquae, cum unum globum constituent in medio mundi, et 10 et 7 leucae cum dimidia gradu uno correspondeant; 360 gradibus, quos ambitus continet caelorum, 6300 leucae corresponderent in circuitu terrae plus minusve. Cumque centrum sit in medio terrae, a terrae circumferentia usque ad centrum erunt 1002 leucae plus minusve, terraeque diameter erit 2004 leucarum plus minusve.

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<sup>1</sup> *Correxist Obara ex hictu.*

<sup>2</sup> *Ms. in margine: Xecaino grau 360. Noriva 6300 ri. Coreyori centro made va 1002 ri. Diametrova 2004 ri. Vid. infra f.25.v. init.*



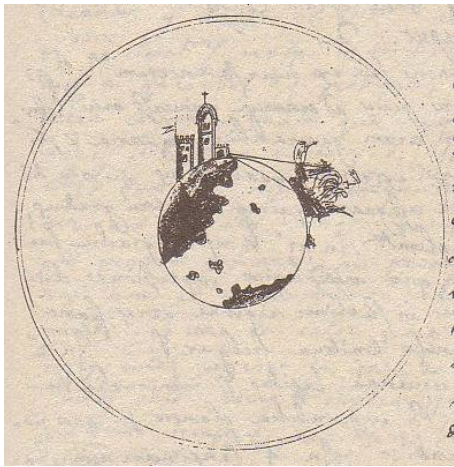


Fig. 6

But that earth and water constitute one globe, so that sea would not be higher than land, is evident from the reasons adduced for the rotundity of earth. For the same experiences prove that earth and water are round. First this is proven, since those who sail 17 *leucæ* and a half always make up one degree, just as we said concerning those who travel. Secondly, since innumerable islands are found everywhere in the middle of the sea, which could not happen, if the sea were much higher than land. Thirdly, since it would be the greatest and perpetual miracle, that the sea, if it is higher than earth, should not flow down into the lower place and flood the entire land. Fourth, since when a ship comes close to port the summits of mountains appear first, then the mountains become slowly visible more and more, which cannot happen, if the sea were much higher than land. For then clearly land in its entirety would appear even from far away, just as one who ascends above a high mountain sees all of the lower land with a single view of the eye. Fifth, since the shadow of earth does not eclipse the moon by itself, but the shadow of both elements, namely of water and earth. This shadow, however, is round, as we have said. Therefore, water and earth constitute a single globe.

From these it is evident first that there are antipodes in the world. For it has been found by long navigation that almost all regions of the earth are inhabited, and it has happened not once that a ship went out from one port, and as it sailed always to the west, after much time and space it returned to the very same port; from this fact, by experience, what natural reason used to dictate has been established, that there are truly antipodes in all of the world.

Secondly, it is evident that earth on account of its greater heaviness possesses the center, but that water is carried above the very earth, so that the depth of the sea does not seem to commonly exceed one or two *leucæ*. For everywhere, even in the middle of the ocean, innumerable islands and rocks are found, which [f.25v.] indicates that earth is not exceedingly deep under the sea.

Thirdly, it is evident what the magnitude of earth and water is, since they constitute one globe in the middle of the world, and 17 *leucæ* and a half correspond to one degree; 6300 *leucæ* in the circuit of earth more or less will correspond to 360 degrees, which the circuit of the heavens contains. And since the center is in the middle of earth, from the circumference of earth all the way to the center there will be 1002 *leucæ* more or less, and the diameter of earth will be 2004 *leucæ* more or less.

Ultimo etiam constat aerem et ignem figuras habere sphaericas; cum aer coniunctus sit terrae et terra sit rotunda, aer etiam eandem figuram habebit. De igne etiam patet, quia ut diximus ignis coniunctus est caelo lunae, sed caelum lunae rotundum est, ignis ergo regio rotunda quoque est. Deinde ignis secundum suam naturam naturaliter ascendit sicut aqua naturaliter descendit, sed ob istam causam aquam rotundam esse diximus. Ignis ergo ob eandem<sup>1</sup> rotundus erit. De tribus autem aeris regionibus suo loco dicemus.

### **De mixtis et de eorum causis.**

#### **Caput 2.<sup>2</sup>**

Ex diversa elementorum mixtione seu ex diverso temperamento quattuor primarum qualitatuum variae rerum species ad ornatum universi ortum habuerunt. Elementa enim omnium rerum generabilium materia et principia sunt, composita vero ex eorum qualitatibus mixta dicuntur. Solent autem communiter assignari quinque mixtorum gradus seu genera praeter ipsa elementa. In primo et infimo gradu sunt mixta illa imperfecta, quae meteorologicae<sup>3</sup> impressiones dici solent, eo quod ut plurimum in sublimi regione aeris fiant, qualia sunt nix, grando, tonitrua, fulgur etc. In secundo gradu sunt mixta non viventia, lapides scilicet, mineralia etc., quae vitam non habent. In tertio vegetabilia, plantae scilicet, quae nobiliorem habent modum essendi. In quarto sensitivam animam habentia, animalia scilicet bestia etc. In quinto et supremo gradu homo constituitur. De tribus posterioribus superius diximus in tractatu de anima, cum de triplici anima vegetativa, sensitiva et rationali egimus. Nunc vero de prioribus, et praecipue de meteorologicis impressionibus nobis erit sermo. [f.26r.]

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<sup>1</sup> *Sic Ms., inseruit Obara* [causam].

<sup>2</sup> *Sic Ms., Obara Caput 2./De mixtis et de eorum causis* [vice versa].

<sup>3</sup> *Correximus ex Ms. mete\re/ologicae, Obara metereologicae.*

Lastly, also it is established that air and fire have spherical shapes; as air is joined together to earth and earth is round, air also will have the same shape. Concerning fire this is also evident, since as we have said fire is joined together with the heaven of the moon, but the heaven of the moon is round, therefore the region of fire is also round. Furthermore, fire according to its own nature naturally ascends just as water naturally descends. But on account of that reason we have also said that water is round. Fire therefore will be round by the same [reason]. Concerning the three regions of air, however, we will speak in their proper place.

### **On the composites and their causes.**

#### **Chapter 2.**

From the diverse mixture of elements or from the diverse temperament of the four prime qualities various species of things had their origin for the ornament of the universe. For the elements are the matter and principals of all generable things, compounds on the other hand are called composites from their qualities. Five grades or genera of composites are commonly assigned other than the elements themselves. In the first and lowest grade are those imperfect composites, which are commonly called meteorological impressions, for the reason that they happen mostly in the upper region of air, such as are snow, hail, thunders, lightning etc. In the second grade are composites not living, namely stones, minerals etc., which do not have life. In the third [grade are] vegetables, namely plants, which have a nobler manner of being. In the fourth [grade are] things having a sensitive soul, namely animals, beast etc. Man is constituted in the fifth and highest grade. On the three later ones we have spoken above in the treatise on the soul, when we discussed the threefold soul, the vegetative, the sensitive and the rational. Now, however, our speech will be on the former ones, and especially the meteorological impressions. [f.26r.]

§ 1.<sup>1</sup>

Est autem imprimis nobis notandum circa mixtorum naturam mixta non ideo mixta dici, quia in se elementorum naturas et formas contineant.<sup>2</sup> Evidens enim experientia est, ad generationem hominum aut cuiuslibet alterius rei numquam convenire ipsa elementa inter se, nec actualiter praedicta elementa in corporibus humanis vel etiam in aliis mixtis reperiri. De primo enim Adam in Sancta Scriptura refertur<sup>3</sup> ex solo limo terrae compactum esse virtute Dei. De plantis etiam et animantibus ibidem dicitur: Producat terra herbam virentem,<sup>4</sup> et paulo post: Producat terra animam viventem in genere suo, iumenta etc.<sup>5</sup> De volatilibus etiam et piscibus ex aqua productos esse ibidem habetur,<sup>6</sup> nec aliqua fit mentio, quod particulas elementorum Deus assumens eaque commiscens mixtum aliquod produxit. Et quidem actualiter nunc in nobis non esse ipsa elementa secundum proprias substantias et formas probatione non indiget. Alias enim homo iam non homo, sed cumulus et aggregatum quid ex terra, aqua, aere,<sup>7</sup> et igne diceretur.

Dicuntur ergo mixta ex elementis componi duplici de causa. Primo quia elementorum materia in mixtorum materiam convertitur; neque enim, quando arbor verbi gratia producitur, ex nihilo producitur, sed terrae corrupta materia, quae prius fuit sub forma terrae, nunc sub forma arboris est. Idem dico de piscibus et aliis, quae ex aqua producuntur. Secundo mixta dicuntur ex elementis componi, quia quattuor illic<sup>8</sup> primae qualitates, quae propriae passiones, seu propria accidentia quattuor elementorum sunt, ad temperamentum redactae reperiuntur in omnibus mixtis, non ita ut calor, qui est in me, verbi gratia sit idem numero calor, qui erat in igne; hoc enim fieri non potest, sed calor similis calori ignis et eiusdem speciei. Huiusmodi autem quattuor qualitatum temperies nec forma substantialis mixtorum est, neque ipsorum elementorum, sed est quasi fundamentum quoddam et dispositio necessaria ad productionem et conservationem cuiuslibet mixti,

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<sup>1</sup> *Inseruit Obara.*

<sup>2</sup> *Correxit Obara ex contineat.*

<sup>3</sup> *Sic Ms., Obara infertur.*

<sup>4</sup> *Sic Ms., Obara viventem. OT Gn. 1.11.*

<sup>5</sup> *OT Gn.1.24.*

<sup>6</sup> *OT Gn.1.20-22.*

<sup>7</sup> *Sic Ms., omisit Obara.*

<sup>8</sup> *Sic Ms., Obara illae.*

**§ 1.**

We must first note concerning the nature of composites that composites are not so called for the reason that they contain in themselves the natures and forms of the elements. For it is obvious by experience that for the generation of humans or of whatever other thing the elements themselves never come together on their own, nor are the aforementioned elements actually found in human bodies or even in other composites. For concerning Adam, first, it is reported in the sacred scriptures that he was compacted from the mud of earth alone by the virtue of God. Concerning plants also and animals it is said in the same place: Let earth produce green grass, and a little later: Let earth produce living soul in its own kind, cattle etc. It is also asserted in the same place concerning birds and fishes that they were produced from water, nor is some mention made that God, taking up particles of elements and mixing them together, produced some mixed thing. And indeed it needs no proof that now actually in us the elements on their own according to their own substances and forms are not present. For otherwise, man would no longer be called man but some heap and aggregate of earth, water, air, and fire.

Composites therefore are said to be compounded of elements due to a double reason. First, since the matter of the elements is converted into the matter of the composites. And indeed, when for example a tree is produced, it is not produced from nothing, but the corrupted matter of earth, which was first under the form of earth, is now under the form of a tree. I say the same concerning fishes and others, which are produced from water. Secondly, composites are said to be compounded of elements, since in them the four prime qualities, which are the proper passions, or proper accidents of the four elements, are found redacted to a temperament in all composites, not so that the heat, which is in me, would for example be the same heat by number as the one that was in fire; for this cannot happen, but a heat similar to the heat of fire and of the same kind [is in me]. The temperament, however, of the four qualities is of such a kind and is neither the substantial form of composites, nor of the elements themselves, but it is as it were some kind of foundation and disposition necessary for the production and conservation of every kind of composite,

ita ut, sicut ignis produci non potest in ligno, nisi prius lignum calefiat et exsiccetur;<sup>1</sup> non tamen dicimus illum calorem aut illam siccitatem esse propriam naturam et substantiam [f.26v.] ignis; ita etiam, ut<sup>2</sup> forma hominis vel cuiuslibet mixti producat, necessarium est ut prius materia disponatur et attemperetur primis<sup>3</sup> quattuor qualitatibus, ut possit deinde propria forma introduci, propriasque operationes exercere. Unde unaquaeque forma naturalis tale temperamentum quattuor primarum qualitatatum exposcit, ut possit conservari. Atque ideo<sup>4</sup> mixta ex elementis componi est unius vel plurium elementorum in se materiam habere, et simul ad sui productionem et conservationem quattuor qualitatatum temperiem requirere, quod in elementis non reperitur. Aqua enim dum calefit non perficitur, sed potius ad corruptionem disponitur, et ideo non mixtum, sed elementum est.

Hinc patet necessarium non esse, ut mixtum habeat in se omnium elementorum materiam, sed sufficit, ut eorum habeat virtutes, quattuor scilicet qualitates ad temperamentum redactas. Secundo sequitur: Mixta sicut magis participant de uno elemento quam de alio, ita etiam magis gravia aut levia sunt, verbi gratia quae<sup>5</sup> frigiditatem cum siccitate coniungunt, quia terream compressionem habent, graviora sunt; quae vero calorem simul cum siccitate habent praedominantem, quia igneam referunt naturam, multo ceteris leviora sunt, et sic de singulis qualitatibus.

## § 2.

Secundo notandum est sublunarem hunc mundum in suis operationibus omnino dependere a corporibus caelestibus, ita ut sol, luna et stellae tamquam causae universales concurrant simul cum agentibus particularibus, leone scilicet, equo, homine etc., ad omnium rerum generationes. Et hoc ipsa experientia manifestissimum est in plantis; solis enim accessu et calidis influentiis omnia virescunt et florent, recessu vero flores et folia amittunt.

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<sup>1</sup> *Correxit Obara ex exciscetur.*

<sup>2</sup> *Inseruimus ut.*

<sup>3</sup> *Correximus ex quibus.*

<sup>4</sup> *Correximus ex adeo.*

<sup>5</sup> *Sic Ms., Obara quando.*

so that, just as fire cannot be produced in wood, unless wood is heated and dried first; yet we do not say that that heat or that dryness is the proper nature and substance [f.26v.] of fire. So also it is necessary, in order for the form of man or of whatever composite to be produced, that first the matter be disposed and tempered with the four prime qualities, so that then its proper form can be introduced, and exercise its own operations. Whence each natural form demands such a kind of temperament of the four prime qualities, so that it may be conserved. And for this reason, the fact that composites are composed of elements means that they have the matter of one or more elements in themselves, and that at the same time they require the temperament of the four qualities for their own production and conservation, a feature that is not found in elements. For when water is heated, it is not perfected, but rather is disposed towards corruption and for this reason it is not a composite, but an element.

Hence it is evident that it is not necessary for a composite to have the matter of all elements in themselves, but it is sufficient for it to have their virtues, namely the four qualities redacted to a temperament. Secondly, this follows: To the degree that composites take in from one element more than another, so they become either heavier or lighter. For example, those things which join coldness with dryness, since they have earthly compression, are heavier. Those things, however, that have heat predominating with dryness, since they represent a fiery nature, are much lighter than others, and so forth concerning single qualities.

## § 2.

Secondly, it must be noted that this sublunary world in its operations depends overall on celestial bodies, so that the sun, the moon and the stars concur as universal causes together with the particular agents, namely with a lion, a horse, a human being etc., for the generation of all things. And by experience itself this is most manifest in plants; for with the accession of the sun and its hot influences all things grow green and flower, but with its recess, they lose flowers and foliage.

Patet etiam in conchyliis,<sup>1</sup> et multorum animantium medullis, quae usque ad plenilunium crescere conspiciuntur,<sup>2</sup> decrescunt vero usque ad coniunctionem; patet etiam in corporibus humanis, in quibus variae caelorum<sup>3</sup> impressiones varios causare solent effectus, morbos, pestes etc. Nec hoc solum, constat enim mures, conchylia<sup>4</sup> et alia huiusmodi animalia imperfecta non via generationis ordinariae, sed virtute solis et lunae generari, ita ut elementa materiam videantur praebere loco matris; sol autem et [f.27r.] luna suis influentiis simul cum qualitatibus elementorum eam disponant viventiaque producant. Unde fit, ut sicut rerum omnium seminibus mirificam Deus dedit virtutem, ut possint iuxta genus suum viventia et non viventia producere, cum tamen ipsa semina vitam non habeant, ita etiam solis et lunae radiis et influentiis vim dedit, ut propria virtute simul cum qualitatibus elementorum aliqua etiam viventia possent producere; non autem omnia, sed ea<sup>5</sup> sola, quae ex putrefactione generari solent. Sed dicet aliquis, in quo virtus haec solis, lunae et stellarum consistat.<sup>6</sup> Dicimus primo: Medio lumine et motu in haec<sup>7</sup> agere inferiora; sol enim radiis sui luminis reflexis<sup>8</sup> in terra calorem producit, quo medio omnia conservat, vivificat; tunc autem maiorem calorem influit, cum proxime ad nos accedens radios directos emittit; atque hinc fit, ut in hieme, tempore etiam matutino et vespertino, non adeo magnum calorem causet, quia tunc radios directos non emittit; atque ideo<sup>9</sup> per reflexionem multiplicari non possunt in semetipsis; in vere autem et in meridie, quia directius<sup>10</sup> radios effundit super terram, ipsimet radii magis magisque multiplicantur, et in semetipsos reflectuntur;<sup>11</sup> unde etiam maiorem calorem producant. De luna etiam manifestissimum est suo lumine humiditatem influere. Secundo etiam dicimus solem et lunam particulares alias influentias habere, ita ut non solum medio lumine, sed etiam specialibus virtutibus sibi a Deo datis in haec inferiora agant.

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<sup>1</sup> *Correximus ex Ms. conchirijs, Obara conchireis.*

<sup>2</sup> *Correxit Obara ex conspiciunt.*

<sup>3</sup> *Sic Ms., Obara caloris.*

<sup>4</sup> *Correximus ex Ms. conchiriä Obara conchireia.*

<sup>5</sup> *Ms. e\ta.*

<sup>6</sup> *Correxit Obara ex consistant.*

<sup>7</sup> *Ms. ~~haec~~ \in haec/.*

<sup>8</sup> *Correxit Obara ex refrexis.*

<sup>9</sup> *Correximus ex adeo.*

<sup>10</sup> *Sic Ms., Obara directos.*

<sup>11</sup> *Correxit Obara ex refr'ectuntur.*



This is evident also in shellfish and in the marrows of many animals, which are seen to grow all the way to the full moon, but decrease all the way to the conjunction. It is also evident in the human body, in which various impressions of the heavens are accustomed to cause various effects, diseases, pestilence etc. And not only this, for it is agreed that mice, shellfish and other imperfect animals of this kind are generated not by the ordinary way of generation, but by the virtue of the sun and the moon, so that the elements seem to provide the matter in place of a mother. However, the sun and [f.27r.] the moon with their own influences dispose it together with the qualities of the elements and produce the living things. Whence it happens, that just as God gave a wondrous virtue to the seeds of all things, so that they can produce living and non-living things according to their own species, although the seeds themselves have no life, so also He gave the power to the rays and influences of the sun and the moon, so that they could produce even some living things together with the qualities of the elements; not, however, all things, but only those, which are accustomed to be generated from putrefaction. But someone will say, “in what does this virtue of the sun, the moon and the stars consist?” First we say: They influence these lower things with light and motion as their medium; for the sun produces heat on earth with the reflected rays of its light, by which medium it conserves, [and] vivifies all things. It, however, pours in more heat at such times, when it approaches us most closely and emits straight rays; and hence it happens, that in winter, [and] also in the morning and in the evening, it does not cause such great heat, because at such times it does not emit straight rays; and for this reason they cannot be multiplied into itself through reflection; in springtime, however, and at noon, since it pours out rays more directly over earth, the selfsame rays are reflected; whence also they produce greater heat. Concerning the moon, it is also quite evident that it pours in humidity by its light. Secondly, also we say that the sun and the moon have other particular influences, so that they influence these lower things not only with their light as the medium, but also by special virtues given to them by God.

### § 3.

Verum propius ad impressiones meteorologicas accedentes dicimus in communi harum impressionum quattuor esse causas, sicut et omnium aliarum rerum: est enim causa efficiens, materialis, formalis et finalis. Causa efficiens universalis sunt caelestium corporum influentia, materialis<sup>1</sup> vapores seu exhalationes, quae elevantur a terra et aqua, formalis causa est uniuscuiusque forma, scilicet forma nivis, pluviae etc., finalis causa est universi ornatus, et fructuum temporumve varietas.

Pro quo notandum virtute et calore solis et aliorum<sup>2</sup> astrorum influxu elevari a terra et aqua vapores seu fumos quosdam, quales ex aqua igni apposita elevari videmus, qui partes terrae et aquae tenuiores et [f.27v.] subtiliores sunt virtuteque et calore solis calefactae et exsiccatae a terra et aqua resolvuntur et in superiorem regionem elevantur. Sunt autem hi vapores seu fumi in duplici differentia; quidam enim humidi et calidi sunt; hi nimirum, qui ex aqua vel locis humidis elevantur,<sup>3</sup> vapores dicuntur, ex quibus postea pluviae,<sup>4</sup> venti et alia huiusmodi generantur. Alii vero sicci et calidi sunt; hi scilicet, qui ex terra et locis siccioribus exhalantur, qui exhalationes vocantur, ex quibus cometae et aliae impressiones generari solent. Hi vapores et exhalationes non omnino differunt a terra et aqua, sed aliquo modo earum naturam retinent, videlicet exhalatio sicca est sicut terra, sed propter calorem, quem a terra recipit, superius elevatur; vapor etiam humiditatem aqueam retinet, sed propter calorem rarefit et ascendit. Fit ergo ex his, ut materia remota sint tantum terra et aqua, proxima vero vapor et exhalatio.

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<sup>1</sup> Sic Ms., Obara materiales.

<sup>2</sup> Omissit Obara.

<sup>3</sup> Ms. ~~et~~.

<sup>4</sup> Ms. plu~~u~~\viæ/, Obara pluvia.

**§ 3.**

But coming closer to meteorological impressions, we say in general that there are four causes of these impressions, just as of all other things. For there is the efficient cause, material cause, formal cause and final cause. The universal efficient cause is the influence of heavenly bodies, the material cause is vapors or exhalations, which are raised from earth and water, the formal cause is the form of each and every thing, namely the form of snow, rain, etc., the final cause is the ornament of the universe and the variety of fruits or seasons.

On this topic it must be noted that by the virtue and heat of the sun and the influence of other stars, certain vapors or fumes rise from earth and water, of such a kind as we see rising from water placed next to fire, which are thinner and subtler parts of earth and water, [f.27v.] and, heated and dried by the virtue and heat of the sun, they melt out of earth and water and rise into the upper region. These vapors or fumes, however, are in a double distinction. For some are humid and hot; that is to say those, which rise from water or humid places, are called vapors, out of which afterwards rains, winds and other things of this kind are generated. But others are dry and hot; namely those, which are breathed out from earth and drier places, which are called exhalations, out of which comets and other impressions are accustomed to be generated. These vapors and exhalations are not altogether different from earth and water, but retain their nature in some way; namely exhalation is dry just like earth, but on account of the heat, which it receives from earth, it is raised higher; vapor also retains a watery humidity, but on account of heat it becomes thin and ascends. Thus from these it so happens, that the remote matter is just earth and water, but the proximate [matter] is vapor and exhalation.

## § 4.

Deinde notandum aerem in tres dividi<sup>1</sup> regiones, in supremam scilicet, mediam et infimam. Hic enim aer (ut diximus) calidus et humidus<sup>2</sup> fit, eius tamen pars, quae ignis regioni proxima est, ex eius vicinitate maxime calida redditur, non tamen in ignem convertitur, quia aeris humiditas ignis<sup>3</sup> siccitati resistit; pars etiam aeris, quae nobis proximior est, ex radiorum solis<sup>4</sup> nimia reflectione, et multitudine vaporum seu exhalationum, quae ex aqua et terra cottidie elevantur, calidior redditur, quam sua postulet natura; media vero regio seu pars aeris frigidissima est, tum quia ad illam calor, sive ignis sive ille, qui in terra ex reflectione radiorum causatur, non pertingit, tum etiam quia media illa pars inter duas calidas regiones, infimam et supremam, existens quasi per antiparistasim frigida redditur. Impressiones ergo ignitae in suprema regione fiunt, cometae scilicet etc.; frigidae, ut grando scilicet etc., in media regione; humidae vero, ut pluvia, in infima regione fiunt, de quibus singillatim agemus.

Verum est tamen has tres aeris regiones non habere inter se aequalem latitudinem, ita ut si verbi gratia tota aeris regio 12 sit leucarum, suprema regio 4 contineat leucas, secunda etiam 4, et tertia totidem continere debeat. Satis enim probabile est aeris mediam regionem in partibus, quae sub utroque polo sunt, ob caloris debilitatem nimiamque frigiditatem multo latiore<sup>5</sup> esse, [f.28r.] infimam vero regionem multo minorem. Sub linea autem aequinoctiali ob nimium calorem directamque radiorum solis reflectionem infima regio aeris latior et maior esse videtur, media vero angustior et minor, sicut in figura apposita patebit. [Fig. 7]

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<sup>1</sup> Ms. dividit, *correx*it Obara.

<sup>2</sup> et humidus *sic Ms., omisit* Obara.

<sup>3</sup> *Sic Ms., omisit* Obara.

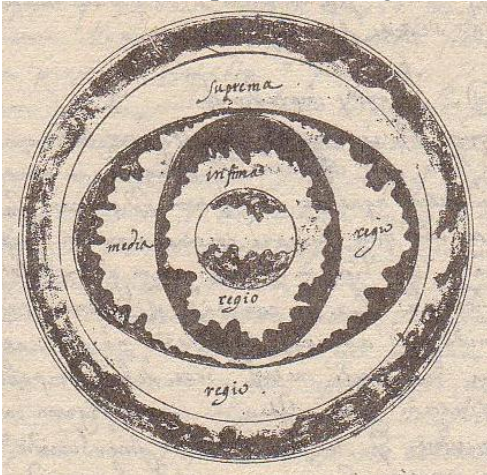
<sup>4</sup> Ms. ~~et~~.

<sup>5</sup> Ms. ~~et~~.

## § 4.

Next, it must be noted that air is divided into three regions, namely into the supreme, middle and lowest. For this air (as we have said) becomes hot and humid, but its part, which is closest to the region of fire, becomes hottest from its vicinity, yet it is, nonetheless, not converted into fire, since the humidity of air resists the dryness of fire. Also the part of air, which is closer to us, becomes hotter than what its nature requires from the excessive reflection of the rays of the sun and from the multitude of vapors or exhalations which rise every day from water and earth. But the middle region or part of air is the coldest, on the one hand because the heat, either of the sun or that which is caused on earth from the reflection of rays, does not pertain to it, and also because that middle part, existing between two hot regions, the lowest and the supreme, is rendered cold as if by antiparistasis. Thus, fiery impressions, namely comets etc., happen in the supreme region; cold ones, such as hail etc., happen in the middle region; humid ones, however, such as rain, happen in the lowest region, which we will discuss one by one.

But it is true that these three regions of air do not have equal breadth between them, so that if, for example, the entire region of the air were 12 *leucæ*, the supreme region should contain 4, the second one also 4, and the third should also contain the same number of *leucæ*. For it is probable enough that the middle region of air is much broader in those



places, which are under both poles, on account of the weakness of heat and excessive coldness, [f.28r.] and that the lowest region on the other hand is much smaller. Under the equinoctial line, however, on account of excessive heat and the direct reflection of the rays of the sun, the lowest region of air seems broader and larger, and the middle region on the other hand narrower and smaller, just as will be evident in the juxtaposed figure.

Fig. 7

Ultimo notandum antiparistasim idem esse quod contrariis iuxtaposito naturalis<sup>1</sup>: est enim elementis, ut sibi contrario resistant, frigidum verbi gratia calido et humidum sicco, et e contra. Contingit autem saepe, ut calor verbi gratia videatur quodammodo frigidum fugere et reconcentrari seu adunari in interiori parte, ut facilius contrario frigori<sup>2</sup> possit resistere, sicut in aqua fontium videre est, et in corporibus humanis; calor enim ille, qui in terra erat, in hieme videtur quodammodo recludi in inferiori parte terrae, unde fit, ut aqua fontium calidior appareat;<sup>3</sup> in vere autem contrario fit, cuius ratio esse videtur, quia vapores seu exhalationes calidae, quae in tempore veris producuntur in terra, in hieme non permittuntur exire a terra propter maximam frigiditatem aeris; unde in inferiorem terrae partem descendentes, terram ipsam aquamque calefaciunt. In vere autem e contrario fit; cum enim aer calefiat, naturaliter exhalationes illae et vapores in terra reclusi superius ascendunt, et partes frigidiores remanent, atque ideo<sup>4</sup> aquam et terram in frigidare valent; idem etiam contingit in corporibus humanis et ob eandem causam grando et lapides in media aeris regione generantur, ut statim dicemus.

**De impressionibus meteorologicis<sup>5</sup>**  
**in particulari**  
**Caput 3.<sup>6</sup>**

[f.28v.] Cum multae sint impressiones seu immutationes elementorum, quaedam ignitae, quae ut plurimum in suprema regione fieri solent, quaedam frigidae, quae in secunda regione congelantur, aliae humidae, nubes scilicet, pluvia, ros etc., siccae quaedam, venti in infima regione; immo nec aquae et terrae suae<sup>7</sup> desint impressiones seu immutationes, ut suo ordine procedamus, prius de ignitis, deinde de reliquis dicemus.

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<sup>1</sup> Ms. naturale, *correxit Obara.*

<sup>2</sup> Sic Ms., *omisit Obara.*

<sup>3</sup> Ms. apparet, *correxit Obara.*

<sup>4</sup> *Correximus ex adeo.*

<sup>5</sup> *Correximus ex Ms. Obara metereologicis.*

<sup>6</sup> Sic Ms., *Obara Caput 3./De impressionibus metereologicis/in particulari [vice versa].*

<sup>7</sup> Sic Ms., *omisit Obara.*

Lastly, it should be noted that antiparistasis is the same thing as the natural juxtaposition of opposites: for elements have the characteristic of resisting what is contrary to them, as for example a cold one resists a hot one and a humid one resists a dry one, and vice versa. Indeed it often happens that heat for example seems to flee coldness in some way and to be reconcentrated or united in an interior part, so that it can resist the contrary coldness more easily, just as one can see in the water of fountains and in the human body. For in winter the heat, which was in earth, seems in some way to be shut up in a lower part of earth, whence it happens, that the water of fountains appears to be hotter. In spring, however, the opposite happens, of which the reason seems to be that vapors or hot exhalations, which are produced on earth in the season of spring, are not permitted to go out from earth in winter on account of the greatest coldness of air; whence they descend into a lower place of earth and make earth itself and the water hot. In spring, however, the opposite happens; for as air becomes hot, naturally those exhalations and vapors that had been shut up in earth ascend higher, and the colder parts remain, and for this reason they can make water and earth colder. The same thing also happens in human bodies and on account of the same reason hail and stones are generated in the middle region of air, as we shall say in a moment.

**On meteorological impressions  
in particular  
Chapter 3**

[f.28v.] As there are many impressions or immutations of elements, some of them fiery, which most commonly are accustomed to happen in the supreme region, some of them cold, which congeal in the second region, others humid, namely clouds, rain, dew, etc., some of them dry, namely winds in the lowest region; furthermore, as neither do water and earth lack their own impressions or immutations, first we would speak about the fiery ones, and then about the rest, in order to proceed in due order.

§<sup>1</sup>**De ignitis impressionibus**

Materia proxima, ex qua omnes ignitae impressiones fiunt, sunt exhalationes calidae et siccae, quae virtute solis elevantur in aera nullamque habent humiditatem aqueam admixtam, sed aeream; sicut enim experientia patet, materia illa, quae humorem continet aqueum, ineptissima<sup>2</sup> est ad combustionem, verbi gratia lignum viride. Cum ergo exhalationes dictae facile sive in fulmen, sive in cometam etc., convertantur, manifestissimum est humiditatem aqueam continere non posse; aeream vero seu viscosam humiditatem necessario habere debent, ut possint esse pabulum et nutrimentum ignis: ideo enim cineres ignem in se conservare non queunt, quia licet sicci et calidi sint, humiditate tamen praedicta aerea carent; et e contra tamdiu lucerna durat accensa, quamdiu oleum aut cera durant, ita etiam tamdiu impressio<sup>3</sup> ignita seu ignis in exhalatione durat, quamdiu humidum hoc viscosum non consumitur.

Praedictae exhalationes in aera elevatae, aliquando a nimio frigore circumstante compressae et reconcentratae per antiparistasim accenduntur, aliquando autem ut<sup>4</sup> in suprema regione aeris a nimia vicinitate<sup>5</sup> ignis comburuntur, et hae<sup>6</sup> causae efficientes<sup>7</sup> impressionum ignitarum in communi, et materia ex qua fiunt.

**De Cometis**

Cometae, quae stellae crinitae seu comatae<sup>8</sup> dici solent, licet toto anni tempore fieri possint, possint, communiter tamen non nisi in aestate aut in autumno fieri contingit; huius ratio est, quia his temporibus ob nimiam solis vicinitatem innumerae exhalationes calidae, siccae, et viscosae elevantur a terra, quae in mediam usque regionem aeris tendentes, a nimio frigore compressae adunantur, et quia in maxima sunt quantitate, aeris resistantiam vincunt, et ad supremam usque regionem ascendunt; ubi quia regio ignis et suprema aeris regio a motu primi mobilis

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<sup>1</sup> Sic Ms., Obara §1.

<sup>2</sup> Sic Ms., Obara inaptissima.

<sup>3</sup> Sic Ms., omisit Obara.

<sup>4</sup> Ms. aut \ut/.

<sup>5</sup> Ms. vicinitate ~~solis~~, Obara vicinitate solis.

<sup>6</sup> Ms. hae, Obara haec.

<sup>7</sup> Inseruit Obara [sunt].

<sup>8</sup> Correximus ex Ms. comætæ, Obara cometae.



## §

**On fiery impressions**

The most proximate matter, from which all fiery impressions arise, are the hot and dry exhalations, which rise into the air by the power of the sun and have no watery, but airy, humidity mixed in it. For just as it is evident by experience, that matter, which contains watery humidity, is most unfit for burning, for example green wood. Therefore, since the said exhalations are easily converted into thunder, or into a comet, etc., it is most obvious that they cannot contain watery humidity. But by necessity they ought to have airy or viscous humidity, so that they may be food and nutrition for fire. For ash cannot preserve fire within it for this reason, that though it may be dry and hot, nonetheless it lacks the aforesaid airy humidity. And on the contrary, a lamp stays on fire as long as its oil or wax remains, and so also a fiery impression or fire remains in exhalation as long as this viscous humidity is not consumed.

The aforesaid exhalations, rising into the air, are sometimes compressed and reconcentrated by the excessive surrounding cold and are put on fire through antiparistasis; sometimes, however, as in the uppermost region of the air, it is burned by the excessive closeness of fire, and these are the efficient causes of fiery impressions in general, and the matter from which they arise.

**On Comets**

Comets, which are accustomed to be called hairy or long-haired stars, even though they may happen throughout the year, nonetheless commonly do not arise unless in the summer or in the autumn. The reason for this is because during these seasons, on account of the excessive closeness of the sun, innumerable hot, dry and viscous exhalations rise from earth, which, rising all the way into the middle region of air, are bound together by the excessive cold, and because they are in the greatest quantity, they overcome the resistance of the air, and ascend to the uppermost region; where, because the region of fire and the uppermost region of air are dragged from east to west by the motion of the *primum mobile*,

rapiuntur<sup>1</sup> [f.29r.] ab oriente in occidentem, praedictae exhalationes etiam eodem motu agitantur; unde fit ut simul a calore proprio et a calore aereo, et ab eo, qui ex motu illo rapidissimo<sup>2</sup> causatur (motus enim ut diximus causa caloris est) praedictae exhalationes paulatim accendantur, vel ut Aristoteles vult,<sup>3</sup> quia materia illa maxime disposita est, particula aliqua ignis a sua propria sphaera descendens materiam illam accendit, sicut quotidie fieri contingit in lucerna proxime extincta et fumigante, si iuxta alteram accensam ponatur, aut in pulvere tormentario, si iuxta ignem ponatur. Iuxta variam figuram harum exhalationum variae etiam cometarum figurae apparere solent: aliquando enim pars media crassior est, extrema vero rariora, et tunc videtur tamquam<sup>4</sup> stella crinita; aliquando etiam anterior pars crassior est et reliquae subtiliores, et tunc apparent tamquam pila in capite, quae magnam habeat caudam. Quanto autem tempore durare soleant, licet Plinius dicat non minus quam septem<sup>5</sup> diebus durare nec plus quam quadraginta,<sup>6</sup> falsum tamen, nec certa regula assignari potest; visae<sup>7</sup> enim sunt durare per 70 dies, immo et per sex menses, ut historia refert.

Est autem cometa signum commotionum, bellorum, famis etc. Cum enim cometae generentur ex innumeris exhalationibus siccis et calidis, signum est terram maxime siccam et calidam esse his temporibus, atque ideo<sup>8</sup> fructum edere non posse; unde fames et sterilitas oritur. Deinde secundo, quia ex dictis exhalationibus plerumque venti generantur, ut suo loco dicemus, tempestates significant futuras. Tertium, cum etiam in interioribus partibus terrae ex dicta siccitate et calore multae etiam exhalationes fiant, contingit saepissime tremores terrae causare<sup>9</sup>, pestes etiam et infirmitates aliquando causantur, et bella, quia aer ob nimiam densitatem exhalationum aliquando corrumpitur et pestem causat;

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<sup>1</sup> Sic Ms., *Obara* [f.29.] rapiuntur.

<sup>2</sup> Ms. ~~r~~apidiss°.

<sup>3</sup> Cf. Arist. *Mete.* 341b18-24.

<sup>4</sup> Ms., *Obara* videtur [iterum], omisimus.

<sup>5</sup> Ms. ceptem, *correxit Obara*.

<sup>6</sup> Cf. Plin. *Nat.* 2.22.

<sup>7</sup> Sic Ms., *Obara* visa.

<sup>8</sup> *Correximus ex Ms. Obara* adeo.

<sup>9</sup> Sic Ms., *fortasse pro* causari.

[f.29r.] the aforesaid exhalations also are driven by the same motion; whence it happens that, at the same time by their own heat and by the heat of the air, and by that heat, which is caused by that most rapid motion (for motion, as we have said, is a cause of heat), the aforesaid exhalations are gradually put on fire, or, as Aristotle thinks, since that matter is most fittingly arranged, some particle of fire descending from its own sphere puts that matter on fire, just as it happens every day in a lamp that was recently extinguished and is smoking, if it is placed next to another one that is on fire, or in cannon powder, if it is placed next to fire. Also, according to the various figures of these exhalations, various figures of comets are accustomed to appear. For sometimes its middle part is thicker, and the extremes are thinner, and then it looks just like a hairy star. Sometimes also the front part is thicker and the rest are thinner, and then they appear just like a ball in the head, which has a great tail. As for the length of time while they last, even though Pliny says that they last no less than seven days and no more than forty days, this nonetheless is false, and no certain rule can be assigned. For they have been seen to last for seventy days, and not only that but for six months, as history reports.

Now the comet is a sign of commotions, wars, famine etc. For as comets are generated out of innumerable dry and hot exhalations, they are a sign that the earth is most dry and hot during these times, and for this reason, cannot yield its fruit; whence famine and sterility arise. And secondly, since from the said exhalations winds are generated most of the time, as we shall say in its own place, they signify future tempests. Thirdly, since even in the interior parts of earth from the said dryness and heat many exhalations also arise, it happens very often that they cause earthquakes, also pestilence and infirmities are sometimes caused, and wars, since the air is sometimes corrupted on account of the excessive density of exhalations and causes pestilence;

et quia per respirationem aerem attrahimus, cum ille<sup>1</sup> maximum calidus et siccus sit, dictis temporibus choleram accendit, unde bellorum et litium causa desumitur; non tamen haec necessario sequuntur, sed aliquando. Habent hoc peculiare cometae inter omnes ignitas impressiones, ut moveantur ab oriente in occidens, licet aliquando simul etiam in septentrionem vel in austrum videantur declinare. Primus motus causari<sup>2</sup> videtur a motu divino primi mobilis, sed quia aeris pars illa, in qua cometae sunt, nimis fluida est, [f.29v.] 24 horarum spatio integram circulationem conficere nequit; secundus motus, seu declinatio ad septentrionem vel austrum, a dispositione materiae combustibilis procedere videtur; si enim exhalationes versus austrum sint, in eam partem cometa discurrere videbitur eas comburens, sicut ignis, dum paleam vel stuppam extensam accendit, in eam partem discurrere videtur, in qua maior pars paleae vel stuppae est.

Habent etiam varios colores cometae; aliquando enim subobscuri, aliquando nimis lucentes, aliquando maximi, aliquando minimi sunt, quae omnia ex diversitate materiae causantur; si enim materia crassa sit, magis elucent, si rara, subobscuriores apparent, si in magna quantitate, maximi sunt multumque durant, si in minima, minimi videntur et facile extinguuntur.

### **De lancea et stellis cadentibus**

Cum stellae fixae sint in firmamento sicut nodus in tabula, cadere nullo modo possunt, verum exhalationes praedictae, cum in minori quantitate sunt, quam ut ex eis cometae fiant, antequam ad tertiam regionem aeris ascendant, per antiparistasim compressae in media regione accenduntur, et in eam discurrunt partem, in quam a frigore contrario pelluntur, sicut sal ab igne repellitur, et tunc iuxta materiae quantitatem et dispositionem diversae apparent figurae ignitae; aliquando enim scintillae cadere videntur, quia exhalatio minima erat, aliquando sicut stellae vagantes, si vero materia extensa et dilatata sit, lanceae similis apparent etc.

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<sup>1</sup> Ms. ille#.

<sup>2</sup> Ms. causare, *correxit Obara.*

and since we drag in air by respiration, when that air is most hot and dry, it lights up the cholera during the said times, whence the cause of wars and lawsuits is picked out; nonetheless these things do not follow by necessity, but sometimes. Comets among all the fiery impressions have this peculiar thing, that they move from east to west, even though sometimes they seem also to decline toward the north or the south at the same time. The first movement seems to be caused by the divine motion of the *primum mobile*, but since that part of air, in which the comets are, is excessively fluid, [f.29v.] it cannot finish the entire circulation in the space of 24 hours. The second movement, or the declination to the north or the south, seems to proceed from the disposition of the combustible matter; for if the exhalations are towards the south, the comet will seem to run to that part, burning them up, just as fire, while it puts chaff or tow that is spread out on fire, seems to run into that part, in which there is a greater amount of chaff or tow.

Comets also have various colors. For sometimes they are a little dark, sometimes they are excessively bright, sometimes they are very big, sometimes very small, and all of these are caused by the diversity of their matter. For if the matter is thick, they shine more, if it is thin, they appear a little dark, if it is in great quantity, they are very big and last for a long time, if it is very little, they appear small and are easily extinguished.

### **On the lance and falling stars**

Since stars are fixed on the firmament like a knot on a wooden board, they can fall in no way. But the aforesaid exhalations, when they are in a quantity that is too small for comets to be made from them, before they ascend to the third region of air, are compressed through antiparistasis in the middle region and put on fire, and run toward that direction, into which they are driven by the contrary coldness, just as salt jumps away from fire. And then, according to the quantity and disposition of matter, diverse fiery shapes appear; for sometimes sparks seem to fall, since the exhalation was very small, sometimes they appear like wandering stars, but if the matter is extended and broad, something similar to a lance appears, etc.

### De tonitruo, fulgure et fulmine

Tonitrua praecipue in aestate et autumnno fieri contingunt et in vere, in hieme autem non nisi rarissime propter temporis maximam frigiditatem. Fiunt autem hoc modo: calore solis elevantur simul a terra vapores humidi et calidi, et exhalationes calidae et siccae; sed dum frigidam ad regionem omnes ascendunt vapores, quia naturam aqueam habent, facile calorem adventicium<sup>1</sup> amittunt et in frigidantur in nubesque convertuntur; fit autem aliquando, ut dictae nubes aliquam copiam exhalationum intra se includant, quae frigiditatem et humiditatem nubis refugientes reconcentrantur, et tunc per antiparistasim inflammantur maximoque impetu nubes dirumpunt, et tunc maximus strepitus causatur, dum exhalationes illae accensae exeunt, sicut dum sal in ignem proiectus rescinditur,<sup>2</sup> et contrarium fugiens strepitum facit,<sup>3</sup> immo ignis productus [f.30r.] in bombardam vel sclopo, dum exiit a loco in quo inclusus erat, similem fragorem efficit; fragor igitur ille tonitruus dicitur, et claritas exhalationis accensae fulgur appellatur; quae quidem simul in eodem instanti fiunt, fulgur tamen prius sentitur quam tonitruum, quia species visibiles instantanee producuntur in aere, non autem sonabiles, sicut exemplo patet in scindente lignum vel pulsante campanam in loco distante; prius enim videtur motus, quam sentiatur sonus. Contingit autem aliquando, ut pars nubis inferior crassior sit, atque ideo<sup>4</sup> fulgur non descendat in inferiorem partem, sed in superiore resideat, aliquando vero e contrario contingit; maximus autem strepitus fit, quando nubes ex omni parte densissima est, et exhalationes inclusae sunt in magna quantitate; tunc enim, cum maxima ex utraque parte resistentia sit, si nubes dirumpitur, maximus causatur fragor.

Est autem advertendum, quod sicut in terra ex mixtione exhalationum et vaporum aliquando mineralia et alia huiusmodi generantur, sicut suo loco dicemus, sic etiam in aere aliquando ex nimia coniunctione exhalationum cum nube lapis generatur; hic<sup>5</sup> simul cum fulmine deiectus in terram, fulminis cuneus appellatur;

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<sup>1</sup> Coniecimus ex Ms. advēntium, Obara advintium (sic!)

<sup>2</sup> Correximus ex Ms. Obara resciditur.

<sup>3</sup> Correximus ex Ms. Obara faciunt.

<sup>4</sup> Correximus ex Ms. Obara adeo.

<sup>5</sup> Correxit Obara ex Ms. hi.

### **On thunder, flash of lightning and lightning**

It happens that thunders occur especially in summer and autumn and spring, but not in winter except very rarely, on account of the very great coldness of the season. They occur in this way: by the heat of the sun, humid and hot vapors and hot and dry exhalations rise up from the earth simultaneously; but while all vapors ascend into the frigid region, since they have a water nature, they easily lose their adventitious heat and are made cold and are converted into clouds; and sometimes it happens that the said clouds include within themselves some amount of exhalations, which, fleeing the coldness and humidity of the cloud, are reconcentrated, and then are inflamed through antiparistasis and break open the clouds with a very great force, and then a very great noise is caused, while those exhalations on fire go out, just as when salt thrown into fire splits and, fleeing its contrary, makes a sound; furthermore fire produced [f.30r.] in a cannon or a rifle, while it goes out from the place in which it was enclosed, makes a similar sound. Thus that clash is called thunder, and the brightness of the exhalation on fire is named flash of lightning. These happen to be sure simultaneously in the same instant, nonetheless a flash of lightning is sensed before thunder, since visible appearances, but not those involving sound, are produced instantaneously in air, just as is evident by the example of someone splitting wood or striking a bell in a distant place; for the motion is seen before the sound is sensed. It happens, however, sometimes that the lower part of a cloud is rather dense, and for this reason the flash of lightning does not descend into the lower part, but remains in the upper part, but sometimes the contrary happens. A very big noise, however, occurs when the cloud is very dense in all parts and the exhalations within are in great quantity; for then, since there is a very great resistance in both parts, if the cloud is broken, a very great clash is caused.

It must be noted, that just as on earth minerals sometimes and other things of this kind are generated from the mixture of exhalations and vapors, so also in air sometimes a stone is generated from the excessive conjunction of exhalations with a cloud. This stone, hurled onto earth together with lightning, is called the wedge of lightning.

est autem mirabile hoc in fulmine, ut aliquando hominem percutiens totum in cineres convertat, aliquando vero vestes, carnem et pellem denigratas relinquens, ossa in minutissimas partes confringat, immo quod maius est, gladium in cineres convertens vaginam intactam relinquat; et<sup>1</sup> ut Aristoteles refert,<sup>2</sup> contigit clipeum aereum<sup>3</sup> liquefieri calore fulminis, et tamen lignum intactum remanere, cuius diversitatis ratio esse videtur, quod quando materia fulminis seu exhalationes accensae crassiores sunt, tunc omnia consumunt, dum vero tenuiores et subtiliores sunt, facile res non adeo crassas, sicut sunt caro, lignum et alia huiusmodi, penetrare possunt, et quia vehementissimo impetu rapiantur, ea comburere non valent; dum vero fulmen<sup>4</sup> materiam crassiorem, quae ibi resistit, invenit, vehementer eam accendit, eamque in minutissima resolvit; materia enim crassa facile penetrari non potest, atque adeo fulmen diutius in ea moratur et vehementissima actione et motu eam comminuit, sicut pila bombardae<sup>5</sup> moenia durissima comminuit, stuppam vero vel<sup>6</sup> quid simile facile pertransit; ignis etiam plus ferrum distans quam aerem sibi propinquum adurit. Est ergo tonitruum fragor causatus ab exhalatione adusta, dum nubes dirumpit, fulgur est claritas diffusa ab exhalatione accensa. Fulmen eadem sunt exhalationes procedentes<sup>7</sup> [f.30v.] ex nube nimis accensae adunatae, et vehementissimo motu descendentes in terram. Cuneus fulminis lapis est in nube generatus, qui raro, sed aliquando simul cum fulmine descendit.

### **De aliis ignitis impressionibus, quae fiunt in infima regione<sup>8</sup>**

Contingit saepissime, praecipue in aestate, coruscationes quasdam seu inflationes subito sine tonitruo apparere, quae etiam<sup>9</sup> eodem momento facile extinguuntur: Et hoc dupliciter fit, vel tempore nubilo<sup>10</sup> vel sereno, praecipue versus horizontem.

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<sup>1</sup> *Sic Ms., Obara vel.*

<sup>2</sup> *Arist. Mete. 371a25-31.*

<sup>3</sup> *Sic Ms., Obara oreum*

<sup>4</sup> *Ms. \fulmen/.*

<sup>5</sup> *Sic Ms., Obara bombardae.*

<sup>6</sup> *Sic Ms., Obara ut.*

<sup>7</sup> *Correxit Obara ex procidi-entes.*

<sup>8</sup> *Ms. C., omisit Obara.*

<sup>9</sup> *Sic Ms., omisit Obara.*

<sup>10</sup> *Ms. ~~et~~, Obara et.*



This is the amazing thing about lightning, that it sometimes hits a man and changes his whole being into ashes, but sometimes it leaves clothing, the flesh and skin blackened and crushes the bones into the smallest fragments, or rather what is more, it turns a sword into ashes and leaves the sheath untouched. And as Aristotle reports, it has happened that a bronze shield would be liquefied by the heat of lightning, and yet the wood would remain untouched. The reason for this difference seems to be that when the matter of lightning or the burning exhalations are denser, then they consume everything, but when they are thinner and more subtle, they can easily penetrate things that are not so dense, such as flesh, wood and others of this kind, and since they are snatched with a very great force, they cannot burn them. But when lightning finds a denser matter there which stands in the way, it puts it on fire with great force, and breaks it into the smallest fragments. For a dense matter cannot be easily penetrated, and for this reason lightning stays in it for a longer time and crushes it with a most forceful action and motion, just as a cannonball crushes the hardest walls, but easily goes through tow or anything similar. Fire also heats distant iron more than the air next to it. Therefore the clash of thunders is caused by exhalation which is on fire while it breaks open clouds, a flash of lightning is the brightness diffused from the exhalation which is on fire. Lightning is the same exhalations coming [f.30v.] forth out of a cloud that are very much on fire and are united, and are coming down onto earth with a most vehement motion. The wedge of lightning is a stone generated in a cloud, which rarely, but sometimes descends together with lightning.

**On the other fiery impressions, which occur in the lowest region**

It happens very often, especially in summer, that certain flashes or bursts of wind suddenly appear without thunder, which also are easily extinguished in the same moment. And this happens in two ways, either under cloudy or serene weather, especially towards the horizon.

Si nubilo fiant tempore, causantur a praedictis exhalationibus calidis et siccis, quae ascendentes confricantur cum nubibus frigidis et humidis, et ex illa confricatione facile per antiparistasim accenduntur; verum quia tenues, et unitae non sunt, subito coruscant, et subito etiam consumuntur; quod sic persuaderi videtur; si enim a medio nubium praedictae exhalationes exspirent, non posset non sentiri aliquis fragor. Si vero tempore sereno contingant dictae coruscationes, fieri videntur ex eo, quod exhalationes nimis accensae (neque enim hae nisi in tempore calidissimo fiunt) ascendentes vaporibus obviant,<sup>1</sup> qui simul multiplicati ascendunt, quibus exhalationes allisae accenduntur et coruscant.

Consimili modo ex<sup>2</sup> coemeteriis et patibulis in fervida aestate calidi, sicci et viscosi cadaverum exhalantur fumi, qui in aere calidissimo recepti adiutique solaribus radiis et adunati, aliquando noctu accensi et ad modum lucernarum coruscare videntur.

In navi etiam post tempestatem maximam aliquando in summitate mali quasi lucernulae ardentes conspiciuntur, quas aliqui Santelmo,<sup>3</sup> Sanctum Petrum etc., vocant, quasi dicti sancti in eorum auxilium descendant, quod licet negari non possit aliquando contingere, sicut Beato Anselmo<sup>4</sup> contigisse fertur; verum communiter exhalationes innumerae sunt elevatae ex pice,<sup>5</sup> oleo, corporibus humanis etc., ob nimiam navis agitationem causatae, quae superius ascendentes vehementi aeris impulsu compressae aliquando in summitate mali<sup>6</sup> +eas accendi contingit,+ quam<sup>7</sup> causam<sup>8</sup> Aristoteles et alii philosophi assignarunt ante Christum Dominum natum.

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<sup>1</sup> *Correximus ex Ms. Obara* obviam.

<sup>2</sup> *Ms. ~~et sim~~ \ex/.*

<sup>3</sup> *Correximus ex Ms. Obara* Santermo.

<sup>4</sup> *Correximus ex Ms. Ancermo, Obara* Ancermo [St. Elmo?]....

<sup>5</sup> *Ms. pice.*

<sup>6</sup> *Ms. mali.*

<sup>7</sup> *Sic Ms., Obara* quom.

<sup>8</sup> *Sic Ms., Obara* iam.

If they happen under cloudy weather, they are caused by the aforesaid hot and dry exhalations, which while they ascend rub against cold and humid clouds, and from that rubbing together they are easily put on fire through antiparistasis; but since they are thin and are not united, they flash suddenly and are also suddenly consumed. This appears to be persuasive in the following manner; for if the aforesaid exhalations blow out of the middle of the clouds, it would not be possible that some clash would not be sensed. If, on the other hand, the said flashes happen under serene weather, they seem to happen from the following condition, that exhalations which are excessively on fire (for they do not happen except during the hottest season), while they ascend, come across vapors, which are also ascending in increasing quantity, against which the exhalations, as they crash into them, are put on fire and flash.

In a very similar manner, in hot summer season out of cemeteries and gallows hot, dry and sticky fumes of cadavers flow out, which, received in the very hot air and helped by the solar rays and united together, are sometimes put on fire at night and seem to flash in the manner of lamps.

On a ship also after a very great storm sometimes at the top of the mast burning lamps, as it were, are seen, which some call Santelmo, Saint Peter etc., as if the said saints were descending to help them. It cannot be denied that this could sometimes happen, as is told it happened to the Blessed Anselm. But commonly [the cause] is innumerable exhalations that have arisen from pitch, oil, the human body etc., that are caused by the excessive agitation of the ship, which rising above, compressed by the vehement push of air, sometimes happen to be put on fire at the top of the mast. Aristotle and other philosophers assigned this cause before the birth of our Lord Christ.

## § 2.

### **De impressionibus aqueis, quae in secunda et tertia regione aeris fiunt<sup>1</sup>**

Materia harum impressionum exhalatio esse non potest, cum sit calida [f.31r.] et sicca, quae omnino aquae contrariantur, sed sunt vapores calidi et humidi, qui virtute solis et aliorum astrorum, ut diximus, elevantur et ad secundam regionem pertinentes, partim a frigiditate<sup>2</sup> dictae regionis partim etiam a propria natura, cum sint eiusdem naturae cum aqua, facile in pristinam frigiditatem se reducunt, cum non sit ibi calor ignis, nec ignis obsistens. Unde infrigidati<sup>3</sup> continuo adunantur, atque ideo<sup>4</sup> vel in pluviam vel grandinem convertuntur, ut statim dicemus.

### **De nube et pluvia**

Nubes in media aeris regione communiter generantur, et aliquando in infima, sed raro; in suprema autem numquam, tum quia regio illa suprema calidior est, ut diximus, nec apta ad nubium generationem, tum etiam quia vapores in media regione infrigidati supremam ascendere non possunt, tum praeterea quia regio illa suprema aeris motu diurno ab oriente rapitur in occidentem; unde si nubes in ea generarentur, semper in occidentem discurrere deberent, quod ipsa experientia falsum est. Fit autem nubes hoc modo: vapores humidi et calidi elevati a terra in magna quantitate paulatim adunantur, et in mediam usque aeris regionem ascendunt; ibi a nimia eius frigiditate, coadiuvante propria natura aquea vaporum, infrigidantur et condensantur, ita tamen ut nondum in aquam convertantur; unde nebula ascendens et nubes eiusdem sunt rationis<sup>5</sup> tantumque differunt in hoc, quod nebula rarior, nubes autem densior est. Habent autem nubes diversas figuras et colores; figurae quidem variantur secundum positionem vel quantitatem materiae seu vaporum; colores etiam variantur secundum maiorem densitatem vel raritatem ipsorum vaporum. Unde densiores nubes, si praecipue obumbrentur a sole, subobscuriores apparent, quae vero rariores sunt, albedinem referunt, quod si a claritate solis irradiantur, sicut nix albissime conficiuntur. Ulterius nubes, quae inaequaliter densae et rariae sunt secundum diversas partes, discolores apparent, i.e. multicolores apparent. Nubes autem in multiplici differentia sunt, quaedam pluviales, quae aquam generant, quaedam grandinosae,<sup>6</sup> quaedam nivales, quae nivem pluunt, quaedam a calore solis resolvuntur in ventos, quaedam etiam in nebulas et ros convertuntur.

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<sup>1</sup> Sic *Obara, Ms.* De impressionibus aqueis, quae in secunda et tertia regione/ aeris fiunt § 2 [vice versa].

<sup>2</sup> *Ms.* frigi\di/tate.

<sup>3</sup> *Ms.* infridatæ\i/, *Obara* infrigidatae.

<sup>4</sup> *Correximus ex Ms. Obara* adeo.

<sup>5</sup> *Ms.* rões, *correxit Obara*.

<sup>6</sup> *Sic Ms., Obara* grandinosa.

**§ 2.****On watery impressions, which take place in the second and third region of air**

The matter of these impressions cannot be exhalation, since it is hot [f.31r.] and dry, which [qualities] altogether oppose water, rather it is the hot and humid vapors, which by the power of the sun and of the other stars, as we have said, rise, and when they touch upon the second region, partly by the coldness of the said region, partly also by their own nature, since they are of the same nature as water, they reduce themselves easily into their pristine coldness, since there is no heat of fire there, nor is there opposing fire. Whence they, becoming cold, are at once united, and for this reason they are converted into either rain or hail, as we shall say at once.

**On cloud and rain**

Clouds are commonly generated in the middle region of air, and sometimes in the lowest region, but rarely; never on the other hand in the uppermost region, since that uppermost region is more hot, as we have said, nor apt for the generation of clouds, and also because vapors, made cold in the middle region, cannot ascend to the uppermost region, furthermore because that uppermost region of air is snatched by daily motion from east to west; whence, if clouds were generated in that region, they always ought to rush to the west, which by our very experience is false. A cloud, however, comes into being in the following fashion: humid and hot vapors, having arisen from the earth in great quantity, are united little by little, and ascend all the way to the middle region of air; there, because of its excessive coldness, with the cooperation of the vapors' own watery nature, they become cold and are condensed, in such a way, however, that they would not yet be converted to water; whence, rising mist and cloud are of the same nature and they differ only in this, that mist is thinner, but cloud is denser. Clouds have diverse shapes and colors; their shapes indeed vary according to the position or quantity of their matter or vapors: their colors also vary according to the greater density or thinness of the very vapors. Whence denser clouds, especially if they are shaded away from the sun, appear a little dark, but those that are thinner display a white color, and if they are illuminated by the brightness of the sun, they turn very white, like snow. Furthermore clouds, which are dense and thin unequally in their diverse parts, appear to be discolored, i.e. appear multi-colored. Clouds moreover are in multiple categories, some being pluvial, which generate water, some full of hail, some snowy, which rain snow, some are resolved into winds by the heat of the sun, some are even converted into mists and dew.

Pluviae generantur ex nube; dum enim praevalente frigore, quod in media regione est, vapores elevati maxime condensantur, facile in aquam convertuntur; frigus enim naturaliter res comprimit et condensat, sicut calor [f.31v.] rarefacit. Unde sicut virtute caloris aqua rarefacta in vapores conversa est, ita etiam virtute frigoris vapores condensati in aquae naturam reducuntur, et quia aqua ex natura sua gravior est aere, naturali pondere fertur deorsum pluviaque descendit;<sup>1</sup> est tamen advertendum, quod licet haec condensatio vaporum per se fiat a frigore, acuitur tamen et cogitur frigus a calore aeris circumstantis, ut vehementius condenset, et infrigidet dictos vapores; unde fit, ut tempore maximi frigoris raro pluviae descendant.

Pluviam multipliciter fieri contingit, aliquando enim minutissimae descendunt guttae, aliquando vero grossiores, cuius ratio est, tum quia aliqua materia pluviae deficit, tum praecipue quia guttulae illae descendentes maxime infrigidantur in regione aeris nobis propinqua, unde condensatae minores apparent, sicut communiter contingit in hieme; in vere autem et in aestate, quando maxima copia vaporum est et quia guttulae descendentes a calore infimae regionis rarefiunt, grossiores guttulae apparent, sicut apparent in aqua, quae in hieme minoris quantitatis esse videtur, si tamen igni apponatur, eius calore rarefacta maiorem occupat locum. Aliquando etiam continuo pluit, aliquando vero non nisi instantanee pluvia incipit et deficit, aliquando etiam leniter<sup>2</sup> seu paulatim pluit, aliquando vero non nisi vehementissimo impetu, quorum ratio est, quia taliter aliquando dispositus est aer, ut simul cum pluvia descendit, vapores etiam de novo ascendant et continuo in aquam convertantur, aliquando vero illa condensatio vaporum continuari non potest, unde pluvia brevior est. Pluviam autem instantanee et cum impetu descendere dupliciter potest contingere. Primo, cum pluvia simul cum vento impetuoso descendit, secundo (et hoc praecipue in aestate et autumnno) aliquando enim calor inferioris regionis impetum repente facit in frigiditatem mediae<sup>3</sup> regionis, unde frigiditas per antiparistasim repente augetur, et ex consequenti vapores nubium, qui in dicta regione media sunt condensati, in repentinam pluviam convertuntur, cumque guttulae illae infimam regionem calidam inveniant, ab eius calore rarefiunt,<sup>4</sup> unde fit, ut in aestate repente pluvia grossior generari soleat quam in hieme. Aliquando etiam visae sunt eodem tempore simul cum pluvia ranulae descendere,<sup>5</sup> vel statim ex pluvia et pulvere generari et alia huiusmodi, quorum causa est varia commixtio exhalationum terrestrium cum vaporibus; interveniente etiam vi solis, sicut saepe in paludibus ex commixtione partium terrestrium cum humore [f.32r.] aqueo similes vermes generari solent.

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<sup>1</sup> *Correximus ex Ms. Obara* descendere.

<sup>2</sup> *Correximus ex Ms. Obara* lenter.

<sup>3</sup> *Ms. mediae*.

<sup>4</sup> *Ms. eae* rarefiūt.

<sup>5</sup> *Cf. Titelmans 1564, 151.*

Rain is generated from a cloud; for while due to the prevailing coldness, which is in the middle region, the raised vapors are most greatly condensed, they are easily turned into water; for coldness naturally compresses and condenses things, just as heat [f.31v.] makes them thin. Whence, just as water, made thin by the power of heat, is turned into vapors, so also vapors, condensed by the power of coldness, are reduced into the nature of water, and since water is heavier than air by its own nature, by its natural weight it goes downward and rain falls; it must, however, be noted, that although condensation of vapors happens on its own from coldness, coldness nonetheless is made acute and is gathered together by the heat of the surrounding air, so that it would condense more powerfully and make cold the said vapors; whence it happens, that in a time of greatest coldness, rain rarely falls.

Rain happens to occur in multiple ways, for sometimes very small drops fall, but sometimes larger ones, and the reason for this is as follows: Because some matter of rain is deficient, and especially because those droplets, while they are falling, are made very cold in the region of air that is close to us, whence, being condensed, they appear smaller, just as it commonly happens in winter; in spring, however, and in summer, as the supply of vapors is very great and since the droplets, while they are falling, become thin because of the heat of the lowest region, larger droplets appear, just as they appear in water, which in winter seems to be of smaller quantity, if, however, it is placed next to fire, having been made thin by its heat, it occupies a larger space. Sometimes also it rains continuously, but sometimes rain only instantaneously begins and stops, sometimes also it rains mildly or little by little, but sometimes it rains only with the greatest impetus, and the reason for all this is that air is sometimes disposed in such a way that, as soon as rain falls, vapors also rise again and are converted into water straight away, but sometimes that condensation of vapors cannot be continued, whence the rain is shorter. Rain, however, can chance to fall instantaneously and with impetus in two ways. First, when rain falls together with a strong wind, secondly (and this especially in summer and autumn) because sometimes the heat of the inferior regions suddenly rushes into the coldness of the middle region, whence its coldness is suddenly increased through antiparistasis, and as a consequence, the vapors of clouds, which have been condensed in the said middle region, are converted into sudden rain, and when those droplets find the lowest region to be hot, they become thin because of its heat, whence it happens, that in summer larger [drops of] rain are usually generated than in winter. Sometimes also, together with rain, little frogs have been seen to fall, or to be generated at once out of rain and dust, and other things of this kind, and the reason for all this is the various mixture of earthly exhalations with vapors, with the force of the sun also coming into play, just as often in marshes out of the mixture of earthly particles with watery [f.32r.] humor similar worms are accustomed to be generated.

### De caligine et nebula

Nebula seu caligo duplex est; prima est, quae aliquando pluviam subsequitur, estque superfluitas nubis; sunt enim in nube partes quaedam crassiores, quae facile infrigidari et condensari, atque ideo<sup>1</sup> in aquam converti possunt, quaedam autem tenuiores partes sunt et subtiliores, quae condensari et in aquam converti facile non possunt, sicut etiam hoc in fumi exemplo apparet, qui ex arbore viridi elevatur cum incenditur, tunc etiam partes subtiliores et crassiores habere manifeste conspicitur. Cum ergo partes crassiores nubis in aquam conversae sunt, subtiliores etiam noctis frigore condensantur et in terram descendunt, eamque caligine opplent,<sup>2</sup> et tales nebulae communiter serenitatis indicia sunt, quia aerem purum<sup>3</sup> relinquunt, vaporesque omnes in nebulam convertuntur, quae facili negotio a sole consumitur. Alio modo nebula generatur; aliquando enim vapores crassi elevantur a terra, nec possunt ob suam crassitudinem multum elevari; oriente vero sole coadiuvantur ab eius calore, et tunc si nebula illa rarior est, facile a solis calore absumitur, si vero crassior, et plures alii<sup>4</sup> vapores subtiliores in media aeris regione sunt, nebula haec rarefacta ascendit, et cum aliis vaporibus unita nubem efficit, et in pluviam deinde convertitur.

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<sup>1</sup> *Correximus ex Ms. Obara ideo.*

<sup>2</sup> *Ms. Obara oplent.*

<sup>3</sup> *Sic Ms., Obara puriorem.*

<sup>4</sup> *Ms. #alii.*



### **On mist and fog**

Mist or fog is of two kinds; the first kind is that which sometimes follows rain, and is the leftover of a cloud; for there are certain thicker parts in a cloud, which can easily be made cold and be condensed, and for this reason can be converted into water, but on the other hand there are certain thinner and more subtle parts, which cannot easily be condensed and be converted into water, just as is evident in the example of smoke, which rises from green wood when it is burned, and then it is clearly seen to have thinner and thicker parts. When, therefore, thicker parts of a cloud are converted into water, the thinner parts are also condensed by the coldness of night and descend onto earth, and fill it with fog, and such mists are commonly indications of a serene weather, because they leave the air pure and all the vapors are converted into mist, which is easily consumed by the sun. Mist is generated in another way; for sometimes thicker vapors rise from earth, and they cannot rise much because of their own thickness; but when the sun rises, they are helped by its heat, and then if that mist is thinner, it is easily put away by the heat of the sun, but if it is thicker, and other thinner vapors are in the middle region of air in greater quantity, this mist, rarefied, rises, and, united with the other vapors, creates a cloud, and is then converted into rain.

### De rore et pruina

Roris et pruinae materia eadem est; est enim humor serotinus vel nocturnus, discedente a nobis sole, ex inferiori regione in terram cadens; dum enim sol discedit a nostro hemisphaerio remanet terra quasi fumigans, et tunc succedente nocturna frigiditate, vapores illi tenues condensati in hac infima regione iterum in terram descendunt et in rorem convertuntur; quod si nocturna frigiditas vehementior sit,<sup>1</sup> ros congelatur et in pruina<sup>2</sup> convertitur; unde ros potissimum tempore fit temperato sereno et tranquillo, ita ut nec sol multum vigeat, et nocturna frigiditas sit temperata; si enim sol vehemens sit, omnes vapores, qui elevantur, absumet, et si noctu non<sup>3</sup> fit aliqua frigiditas, vapor ille tenuis, ex quo ros debebat generari, facile a calore aereo in aerem convertetur; quod si tempus serenum est, sed nubilosum, facile praedicti vapores tenues, cum aliis coniuncti, in nubes converterentur, quod si ventus flat, vapores disperget et exsiccabit, [f.32v.] poterunt in rorem condensari, si vero frigus vehemens sit, praedicti vapores non in rorem, sed in pruina<sup>4</sup> convertentur; unde fit, ut ros nec in fervida aestate nec in frigida hieme gignatur, sed praecipue in vere, et aliquando in autumno, quae tempora magis temperata sunt. Pruina vero fit eodem modo, et tempore sereno solum, quae<sup>5</sup> differt a rore in hoc, quod pruina non nisi in nocte adeo frigida fit, quae valeat congelare praedictos vapores ascendentes; unde non nisi in hieme, et in frigidioribus locis cadere solet. Ros et pruina serenitatis indicium esse solent, immo ros maximi caloris futuri sequenti die; cuius ratio est, quia post rorem et pruina<sup>6</sup> remanet aer exoneratus et sine vaporibus, atque ideo<sup>6</sup> pervius solis radiis, a quibus non impeditis<sup>7</sup> calor causatur. Solent autem aliquando simul cum dictis vaporibus exhalationes aliquae seu terrestres partes subtiliores elevari, quae in aere commixtae, dum in rorem conversae descendunt, diversa conficiunt mixta; unde et mel et manna generari solent; quando enim humidum aqueum superat, et terrestres exhalationes pauciores sunt, mel generatur, dum vero partes terrestres et siccae magis abundant, in manna congelatur.

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<sup>1</sup> Sic Ms., Obara fit.

<sup>2</sup> Ms. p~~ru~~i~~n~~am.

<sup>3</sup> Sic Ms., omittit Obara.

<sup>4</sup> Ms. convertetur, correxit Obara.

<sup>5</sup> Ms. q, Obara et.

<sup>6</sup> Correximus ex Ms. Obara adeo.

<sup>7</sup> Sic Ms., Obara impeditus.

### **On dew and frost**

The matter of dew and frost is the same; for it is the wetness of evening or night, which fall onto earth from the lower region when the sun recedes from us; for while the sun recedes from our hemisphere, the earth remains smoking, as it were, and then, when the coldness of night follows, those thin vapors, condensed in this lowest region, fall again onto earth and are converted into dew. But if the coldness of night is more vehement, the dew is congealed and is converted into frost; whence dew occurs most often in a temperate, serene and tranquil season, such as when both the sun is not too strong, and the coldness of night is temperate; for if the sun is strong, it takes away all the vapors which rise, and if there is not some coldness at night, that thin vapor, from which dew ought to have been generated, will be easily converted into air by the heat of air; but if the season is serene, yet cloudy, the aforesaid thin vapors, conjoined with others, would be converted into clouds, but if a wind blows, [and] will disperse and dry out the vapors, [f.32v.] they will be able to be condensed into dew, but if the coldness is vehement, the aforesaid vapors will be converted not into dew, but into frost; whence it happens, that dew is born neither in hot summer nor in frigid winter, but especially in spring, and sometimes in autumn, which are the more temperate seasons. Frost on the other hand arises in the same way, and only in a serene season; it differs from dew in this, namely that frost only arises at night which is so cold that it is able to congeal the aforesaid ascending vapors; whence it is accustomed to fall only in winter, and in the colder places. Dew and frost are usually a sign of serenity, or rather, the dew is [a sign] of the greatest heat on the following day; the reason for this is that after dew and frost the air remains emptied and without vapors, and for this reason pervious to the rays of the sun, from which, when they are not impeded, heat is caused. Sometimes, however, together with the said vapors some exhalations or thinner parts of the earth are accustomed to rise, which, mixed in the air, while they descend after being converted into dew, make up diverse composites; from which both honey and manna are usually generated; for when the wet watery [element] has the upper hand, and earthly exhalations are fewer, honey is generated, but when earthly and dry parts are more abundant, it is congealed into manna.

### De nive

Nix ex eadem materia generatur, qua pluvia, ex nube scilicet existente in media regione aeris, sed requirit multo maiorem frigiditatem quam pluvia. Unde nix tunc generatur, quando nubes, antequam in aquam possit converti, a nimia frigiditate aeris congelatur; habet autem<sup>1</sup> nix candorem maximum,<sup>2</sup> tum quia nubes, ex qua generatur, rara et diaphana est, antequam congelatur; unde sicut aqua diaphana, dum in spumam convertitur, album colorem recipit, ita etiam nix, dum generatur, ex vaporibus diaphanis per illam refractionem partium album recipit colorem, qui maxime lucem refert inter colores; habet etiam nix albedinem ob suam frigiditatem, ut aliqui dicunt, calor enim ut plurimum nigri coloris est causa, frigiditas albi, prout in Aethiopibus et illis, qui septentrionalem plagam inhabitant, experientia docet; est etiam nix mollior grandine, tum ob raritatem materiae, nix enim ex nube rara, grando vero ex aqua fit congelata, tum etiam quia nix non adeo frigida est sicut grando; experientia enim constat, quod nix magis ac magis in frigidata<sup>3</sup> in glaciem congelatur, quod signum est nivem non tantum habere frigiditatis sicut pruina et gelu.

[f.33r.] Communiter nix non nisi in frigida hieme solet contingere, in qua prima et secunda regio aeris maxime frigida est, et communiter supra altissimos montes incidit, ibique magis conservatur quam in convallibus, quia montium cacumina multo magis distant a radiis reflexis solis, qui calorem causant; eo autem tempore, quo nix descendit, aliqualis temperies in aere sentiri solet, quia nix magna ex parte aeris frigiditatem absolvit; unde fit, ut aer magis temperatus remaneat, quam dum glacies aut gelu generatur.

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<sup>1</sup> *Sic Ms., Obara enim.*

<sup>2</sup> *Sic Ms., Obara maximam.*

<sup>3</sup> *Sic Ms., Obara nix magis in frigidata.*

### **On snow**

Snow is generated from the same matter as rain, namely from cloud which exists in the middle region of air, but it requires much greater coldness than rain. Whence snow is generated at that time, when a cloud, before it could be converted into water, is frozen by the excessive coldness of air. Now snow has a very white color, on the one hand because cloud, from which it is generated, is thin and diaphanous, before it is frozen; whence just as diaphanous water, while it is converted into froth, receives a white color, so also snow, while it is generated, from the diaphanous vapors through that refraction of parts receives a white color, which among the colors reflects light the most. Snow also has a white color due to its coldness, as some say; for heat is usually the cause of black color, [and] coldness [is the cause of] white [color], just as experience shows in Ethiopians and in those, who inhabit the northern region; snow is also softer than hail, both because of the thinness of its matter, for snow is made from thin cloud, but hail from frozen water, and also because snow is not so cold as hail; for it is well known by experience, that snow, made colder and colder, is frozen into ice, which is a sign that snow does not have as much coldness as frost and ice.

[f.33r.] Commonly snow is not accustomed to happen except in cold winter, during which the first and second region of air are very cold, and commonly it falls onto very high mountains, and it is conserved there more than in valleys, because the peaks of mountains are much more distant from the reflected rays of the sun, which cause heat; at the time, however, when snow falls, some temperance is usually felt in the air, since snow greatly loosens the coldness of air; whence it happens, that air remains more tempered, than when ice or frost is generated.

### De grandine

Grando in toto anni tempore, sive in hieme sive in aestate, generari potest, licet frequentius in vere et in autumnno generari soleat; diverso enim modo fit in tempore calido ac in frigido. Est autem grando pluvia in aere congelata antequam ad terram perveniat, ita ut, postquam nubes in aquam convertitur pluvialem et descendit, in ipso itinere congeletur a nimio frigore; tempore quidem calido fit grando ex nube calidissima sic calefacta a radiis solaribus; tamen nubes illa calida a frigore mediae regionis condensatur et in aquam convertitur, guttaeque descendentes grossiores sunt, quia ex nube calida descendunt; quod si contingat hanc pluviam partem aliquam aeris infimae regionis, frigidissimam<sup>1</sup> propter pugnam calidi et frigidi, quae in calidis temporibus continuo fit in aere, pertransire, hinc pluvia illa seu guttae aquae congelantur a nimio frigore et in grandinem convertuntur; quod autem haec congelatio grandinis in infima aeris regione fiat, experientia constat; numquam enim grando in altissimis montibus reperitur sed solum in convallibus; tum etiam experientia nos docet grandini immixtas aliquando paleas, pilos et alia huiusmodi in inferiora descendere, quod non contingeret, si in distantissima fieret regione, tum etiam quia, si grando in media<sup>2</sup> aeris regione fieret, antequam ad terram perveniret, dissolveretur, cum praecipue eo tempore infima haec aeris regio nimis calida sit. Aliquando etiam in hieme grando descendit, et tunc eius materia est nubes frigida, quae condensata et in aquam conversa dum descendit, congelatur a nimio frigore tunc vigente. Contingit autem aliquando, ut grando solum descendat, aliquando vero grandini immixta pluvia; cuius ratio est, quia frigus congelans grandinem vim non habuit, ut totam pluviam totam<sup>3</sup> descendentem posset congelare; experientia etiam docet grandinem in tempore calido grossiorem esse, quam quae [f.33v.] in tempore frigido congelatur; cuius ratio est, quia tunc, scilicet in vere aut in aestate, guttae grossiores ob raritatem, quam a calore recipiunt, descendunt, cumque maximo frigori obvient, facillime ab eo penetrantur, et tunc in grossiorem grandinem convertuntur; frigus enim aquam tepidam inveniens eam vehementius penetrat et inrigidat, ut experientia patet.

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<sup>1</sup> Sic Ms., *Obara* frigidissimae.

<sup>2</sup> *Correximus ex Ms. Obara* medio.

<sup>3</sup> Sic Ms. *Obara*, sed fortasse *omittendum*.

### **On hail**

Hail can be generated throughout the year, either in winter or in summer, though it is accustomed to be generated more often in spring and in autumn; for it is made in a different way during a hot season than in a cold season. Hail is rain congealed in air before it reaches the ground, in such a way that, after a cloud is converted into rainwater and descends, it is congealed in the very path by the excessive coldness; during a hot season, to be sure, hail is made from a very hot cloud that is made hot in this way by the solar rays; nevertheless that hot cloud is condensed by the coldness of the middle region and is converted into water, and the descending drops are bigger, since they come down from a hot cloud; but if this rain happens to go through some part of the air of the lowest region, which is very cold due to the battle between heat and cold, which in hot seasons continuously takes place in the air, from here that rain or drops of water are congealed by the excessive coldness and are converted into hail. Now the fact that this congelation of hail takes place in the lowest region of air is certain by experience; for hail is never found on highest mountains but only in valleys; and also experience teaches us that sometimes chaff, hair, and other things of this kind come down mixed with hail, which would not have happened, if it were made in the most distant region, and also because if hail were made in the middle region of air, it would be dissolved before it reaches the ground, especially since in this season this lowest region of air is excessively hot. Sometimes also hail comes down in winter, and at this time its matter is cold cloud, which, while it descends condensed and converted into water, is congealed by the excessive coldness that has strength at that time. It happens that sometimes hail alone comes down, but sometimes rain mixed with hail; the reason for this is because the coldness congealing the hail did not have the force capable of congealing all of the rain, all coming down; experience also shows that hail is bigger during a hot season, than that which [f.33v.] is congealed during a cold season; the reason for this is because at that time, namely in spring or in summer, drops that are bigger due to the thinness, which they receive from heat, come down, and as they come up against maximum coldness, they are most easily penetrated by it, and then are converted into bigger hail; for coldness, coming across tepid water, penetrates and freezes it with greater force, as is obvious from experience.

### § 3.

#### De ventis et aliis immutationibus aeris<sup>1</sup>

Inter mira Dei opera et hoc unum refert Sancta Scriptura, quod producit ventos de thesauris suis, Psal. 134.<sup>2</sup> Verum quia omnia iuxta dispositionem causarum secundarum producuntur a Deo, philosophi materiam ventorum ut plurimum exhalationem calidam et siccam, non tamen multum subtilem aut viscosam esse materiam designant. Cuius ratio, quia venti ut plurimum sicci sunt, et adveniente pluvia ut plurimum remittuntur venti aut cessant; fiunt autem venti communiter hoc modo: praedictae exhalationes siccae et calidae in mediam aeris regionem ascendentes nituntur ulterius ascendere, verum repressae a frigiditate mediae regionis deorsum pelluntur, unde cum magno impetu descendunt; aliquando etiam, exhalatione contra frigiditatem pugnante, quia vincitur a frigiditate, non deorsum, sed ad latus discurrit exhalatio; accedit etiam virtus aliquorum astrorum, a quorum influentiis multae exhalationes elevantur; unde mutatio ventorum non fit communiter, nisi certis mensibus, quibusdam et temporibus; unde fit, ut varietas haec virtutibus astrorum ascribi possit, ut scilicet nunc venti a septentrione, nunc vero a meridie seu ab austro spirent. Verumtamen, quod aliquando vapores etiam possunt esse sufficiens materia ventorum, ita ut vapores rari ascendentes, quia calidi sunt et contrarii secundae regioni maxime frigidae, repellantur in partes inferiores, sicut pelluntur exhalationes calidae per contrariorum pugnam; unde aliquando per multum temporis ventus spirat ex mari, eoque tempore pluvia continua est, nec cum ea pluvia venti cessant; hoc igitur tempore non videtur esse exhalationum copia praesertim supra mare, unde venti spirant, ut tamdiu venti perseverare queant; praecipue igitur ventus generatur ab exhalationibus conquassatis et repulsis a vi frigiditatis mediae regionis, licet aliquando etiam a vaporibus calidis et raris simili modo repulsis generari possit. Quod autem ad generationem venti requiratur huiusmodi pugna calidi cum frigido, experientia patet; plus enim in vere, aestate et autumno sentimus ventorum vehementiam quam in hieme; licet et in hieme [f.34r.] non desint<sup>3</sup> venti multo frigidiores, qui ut plurimum generantur ex exhalationibus<sup>4</sup> excitatis in tempore calido et continuantur vaporibus, qui tunc elevantur, et a vento excitantur et infrigidantur atque ideo<sup>5</sup> in ventum convertuntur.

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<sup>1</sup> Sic *Obara, Ms.* De ventis et aliis immutationibus/ aeriis § 3. [vice versa]

<sup>2</sup> OT *Ps.* (LXX) 134.7.

<sup>3</sup> *Ms.* desint ~~quibus~~.

<sup>4</sup> *Ms.* generantur \ex exhalationibus/.

<sup>5</sup> *Correximus ex Ms. Obara* adeo.



**§ 3.****On winds and other changes in air**

Among the wondrous works of God, the Holy Scripture refers to this one thing, namely that He produces winds from His treasures, Psal. 134. But since everything is produced by God according to the disposition of secondary causes, philosophers designate hot and cold exhalation, but not very subtle or viscose matter, to be the matter of winds for the most part. The reason for this is because winds for the most part are dry, and winds for the most part grow slack or cease when rain is coming. Now winds are commonly made in this way: The aforesaid dry and hot exhalations, rising into the middle region of air, try to rise further, but repressed by the coldness of the middle region, are forced downwards, whence they descend with great force; sometimes also, with the exhalation fighting against coldness, because it is won over by coldness, the exhalation runs off not downwards, but towards the side; also the powers of some stars come into play, by whose influence many exhalations rise up; whence the mutation of winds do not commonly happen except in certain months and certain seasons; whence it happens, that this variety may be ascribed to the powers of the stars, so that namely the winds now blow from the north, but now from the meridian or from the south. But indeed [it is the case] that sometimes vapors, too, can be a sufficient matter of winds, so that thin vapors, when they rise, because they are hot and are contrary to the second region which is very cold, are repelled into lower regions, just as hot exhalations are pushed through the battle of the contraries; whence sometimes a wind blows for a long time from the sea, and during that time there is continuous rain, nor do the winds cease with that rain; during this time therefore, there does not seem to be an abundance of exhalations, especially above the sea, from where the winds blow, so that the winds could persevere for so long; therefore, a wind is chiefly generated from exhalations which are shaken and repelled by the force of coldness of the middle region, although sometimes it could also be generated from hot and thin vapors that have been repulsed in a similar way. Now the fact that this kind of battle between hot and cold is required for the generation of a wind is obvious by experience; for we feel the vehemence of winds more in spring, summer and autumn than in winter; although in winter too [f. 34r.] much colder winds are not absent, which for the most part are generated from exhalations which have been put up during a hot season and are joined to vapors, which arise at that time, and are put up and made cold by the wind and thus are converted into a wind.

12 ventos antiqui assignarunt, unicuique suum nomen imponentes: primus a septentrione flat, et Septentrio dicitur, alius illi contrarius est et Auster nominatur, qui a mundi polis spirare dicuntur, Subsolanus ab ortu solis aequinoctialis, Favonius ab occasu aequinoctiali, et in hoc omnium nationum sententia una fuit, in ceteris autem maior differentia est; siquidem Caeciam<sup>1</sup> ab ortu solis aestivo flare dicebant, Caurum vero ab occasu aestivo, et sic de reliquis, prout in figura sequenti patebit. [Fig. 8]

Verum nostra tempestate attendentes, quod ab omni parte horizontis ventus spirat, horizontem in aequales partes dividentes 8 praecipuos ventos posuerunt, quos rumos

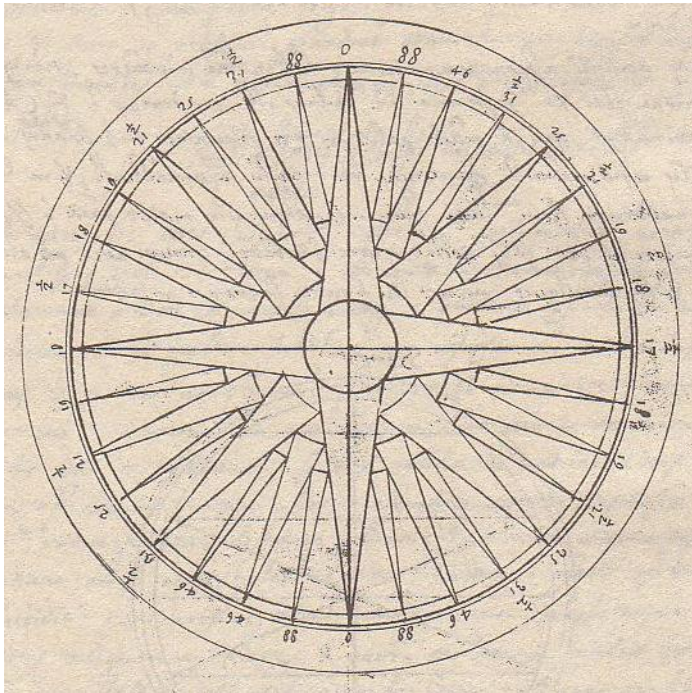


Fig. 9

vulgariter appellant; deinde totidem ventos intermedios designant, quos medias partitas appellant; inter hos<sup>2</sup> 16 ventos praecipuos intermediosque, totidem medios, quos quartas dicunt, inserunt, quibus sua designant nomina, ut in figura sequenti patebit [Fig. 9]; et ita in ista ventorum divisione ita horizon divisus manet, ut octo venti praecipui<sup>3</sup> ad invicem 45 gradibus distent, venti medii inter se, et a ventis praecipuis per 20 et duos gradus distent, quartae etiam distent a mediis per 11 gradus cum quarta parte [f.34v.] alterius, ac tandem inter

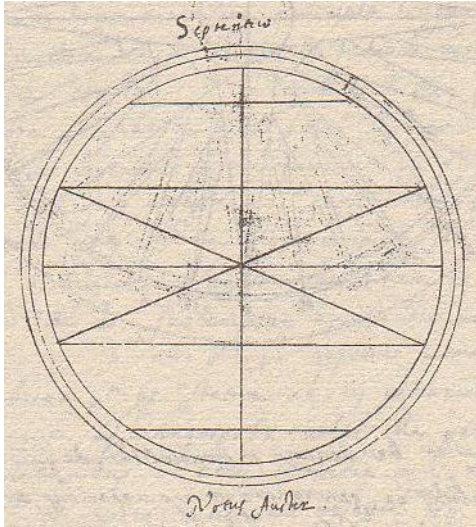
omnes 30 et duo venti assignentur inter maiores et minores.

<sup>1</sup> Ms. ceciam, Obara etiam.

<sup>2</sup> Sic Ms., Obara eos.

<sup>3</sup> Ms. ~~inter~~ octo vent\i\es praecipu\i\es

The ancients assigned 12 winds, imposing onto each its own name: The first one blows from the north, and is called *Septentrio*, another one is opposite to that and is called *Auster*, [these are the ones] which are said to blow from the poles of the world, *Subsolanus* [blows] from the rising of the equinoctial sun, [and] *Favonius* [blows] from the equinoctial setting,



and on this the opinion of all the nations is the same; in the rest, however, there is a greater difference; as indeed they said that *Caecias* blowed from the rise of the summer sun, *Caurus*, however, from the setting of the summer sun, and so for the rest, just as will be made clear in the following figure.

But indeed in our age, noticing that the wind blows from all parts of the horizon, people divide the horizon into equal parts, and positioned 8 chief winds, which they call *rumos* in the vernacular; then they designate the same number of intermediate winds, which they call

**Fig. 8**  
*medias partitas*; in between these they insert 16 chief and intermediate winds, and the same number of middle ones, which they call *quartas*, to which they designate their own names, as will be made clear in the following figure; and thus in that division of winds the horizon remains so divided, that eight chief winds are distant from each other by 45 degrees, the *medios* winds are distant among themselves and from the chief winds by 22 degrees, the *quartas* also are distant from the *medios* by 11 and one fourth of a degree [f.34v.], and finally all in all 32 winds are assigned in between the greater and lesser ones.

Tertio dicendum restat de ventorum proprietatibus, de quibus dicimus ex natura sua omnes calidos esse; generantur enim ex vaporibus, vel praecipue ex exhalationibus virtute solis calefactis et elevatis in aera; verum quia diversa pertranseunt loca, diversas etiam recipiunt qualitates. Venti enim, qui a septentrione et vicinis locis spirant, quia frigidissima pertranseunt loca, et ipsi frigidi et sicci sunt; Auster vero, dum loca maritima et humida pertransit, humidus est etiam, et<sup>1</sup> aquosus nubesque generat,<sup>2</sup> quas Septentrio communiter dissolvit et dissipat; et ita, quo venti magis coniunguntur Septentrioni, ut plurimum plus participant de frigiditate, quo vero plus Austro coniunguntur magis participant de contrario. Verum est tamen hoc non universaliter in omni regione contingere: hi enim, qui versus Austrum extra tropicum Capricornii habitant, frigidiores sentiunt Austrum, calidiores [f.35r.] vero Septentrionem; communiter tamen Subsolanus et Zephyrus, qui ab oriente et occidente in<sup>3</sup> Aequinoctialem flant, reliqui omnes calidiores propter maximam vicinitatem ad solem.

Sed restant aliquot dubia. Primum, cur tempore calidissimo, frigidissimo non soleant<sup>4</sup> venti spirare. Respondetur, tempore calidissimo<sup>5</sup> vi solis exhalationes quidem elevari, sed vehementi calore subtilisari et extenuari, ita ut facile usque ad tertiam regionem pervenire, tempore et frigidissimo, quia vis solis tenuissima est nec potest exhalationes, quae in ventos convertantur, elevare; unde venti tunc tempore non sentiuntur, sed praecipue vigent in vere et autumno. Docet autem Aristoteles,<sup>6</sup> quod venti in ea parte, ex qua flare incipiant, vim habent imbecillem, quo vero longius progrediuntur, propter maiorem commotionem aeris adiacentis maiorem vim habent, sicut in fluviiis experientia constat. Secundum dubium est, cur post solstitium aestivum vel prope incipiant vigere venti septentrionales, contra vero post solstitium hiemale venti vigeant ex parte australi.<sup>7</sup> Respondetur cum Aristotele<sup>8</sup> solem suo accessu ad Septentrionem plurimas exhalationes excitare, quae postea, cum incipiat sol ab illis partibus recedere, a nimia subsequente frigiditate in ventos convertuntur; quod idem etiam suo tempore existentibus in parte australi<sup>9</sup> contingit. Tertium, cur aliquando repente ventus<sup>10</sup> mutatur, ita ut nunc ab una parte, et statim ab eius contraria spiret.

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<sup>1</sup> Sic Ms., omisit Obara.

<sup>2</sup> Correxist Obara ex Ms. generat.

<sup>3</sup> Inseruit Obara.

<sup>4</sup> Sic Ms., Obara solent.

<sup>5</sup> Ms. calidissim~~um~~o/.

<sup>6</sup> Arist. Mete. 361b1-8.

<sup>7</sup> Correxist Obara ex Ms. Austrari.

<sup>8</sup> Arist. Mete. 361a10-12.

<sup>9</sup> Correxist Obara ex Ms. Austrari.

<sup>10</sup> Sic Ms., omisit Obara.

Thirdly, it remains to be said about the properties of winds, on which we say that by their nature all of them are hot; for they are generated from vapors, or chiefly from exhalations made hot by the power of the sun and elevated into air; but since they go through diverse places, they also receive diverse qualities. For winds, which blow from the north and nearby places, since they go through very cold places, are themselves cold and dry; but the south wind, while it goes through places that are next to the sea and are humid, is also humid and watery and it generates clouds, which the north wind commonly dissolves and dissipates; and so, for the most part, to the degree that winds are joined more to the north wind, they get more of the coldness, but to the degree that they are joined more to the south wind, they get more of the opposite. Nonetheless it is true that this does not happen universally in all regions; for those who live to the south outside the Tropic of Capricorn feel the south wind to be colder, but the north wind [f.35r.] to be hotter; nonetheless, commonly the east wind and the west wind, which blow from the east and the west into the Equinox, [and] all of the rest are hotter because of their very great vicinity to the sun.

But some doubts remain; first, why are winds not accustomed to blow in the hottest [and] coldest seasons. The answer is that, during the hottest season, exhalations do indeed rise by the force of the sun, but they are made subtle and thin by the vehement heat, so that they easily come all the way to the third region, and during the coldest season, because the force of the sun is very thin and cannot bring up exhalations, which might be converted into winds; whence winds are not felt at this time, but they are chiefly vigorous in spring and autumn. But Aristotle teaches that winds have a weak strength in that part, where they begin to blow, but the longer they progress, due to the greater commotion of the adjacent air, they have greater force, just as is clear by experience in rivers. The second doubt is why after the summer solstice or thereabouts the north winds begin to be strong, but on the contrary, after the winter solstice the winds are vigorous from the southern part. Together with Aristotle, the answer is that the sun, by its approach to the north, brings up very many exhalations, which afterwards, when the sun begins to recede from those parts, are converted into winds by the subsequent excessive coldness; and the same thing also happens in its own time to those who are in the southern region. Thirdly, why does the wind sometimes change suddenly, so that now it blows from one direction, and immediately from a contrary direction?

Respondetur id triplici de causa contingere<sup>1</sup> posse, vel quia illa pars plurimis abundat exhalationibus ob aeris temperiem aptis ad hoc ut<sup>2</sup> in ventos convertantur, vel quia spirante spirante vento ab oriente v.g. in occidente<sup>3</sup> dictae exhalationes recipiuntur, quae dum invenient partem occidentis repletam aliis exhalationibus, iterum revertuntur propulsae ab illis in partem orientalem, vel etiam tertio ob aliquam peculiarem influentiam caloris, quae propter diversam terrae dispositionem magis in una parte quam in alia sortitur<sup>4</sup> effectum ventosque causat.

### De ecnephia<sup>5</sup>, typhone, et presteris

Ecnephias<sup>6</sup> seu ventus procellosus, qui et procella vocatur, fit eo modo, quo fulmen, nisi quod exhalatio vapore seu nube circumdata crassior est et minus viscosa, et proinde contingit, ut interdum inflammetur; itaque cum haec exhalatio nube circumdata a frigiditate ipsius nubis aut mediae [f.35v.] regionis aeris deorsum magno cum impetu pellitur, excitatur ecnephias, seu procella<sup>7</sup>; estque plerumque ventus vehementissimus adeo, adeo, ut brevissime naves subvertantur,<sup>8</sup> nisi vela contrahantur; quare nautae sub linea aequinoctiali, ubi hoc frequentius contingit, sollicito curant, ut cum primum apparuerit nubes procellosa, statim vela demittant; ex qua nube pluit aqua calida, ex qua subito vermes fiunt, et vestes, quas contegit, putrefiunt, elevatque in carne vesiculas.

Typhon vero seu turbo ex eo fit, quod a diversis nubibus seu a diversis partibus eiusdem nubis<sup>9</sup> pelluntur exhalationes in partes oppositas, ex quibus generatur ecnephias; hae vero exhalationes sive ecnephiae in unum locum convenientes, et in oppositas partes ferri nitentes, mutuo pugnant;

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<sup>1</sup> Ms. ...causa ~~id~~ contingere...

<sup>2</sup> Inseruit Obara.

<sup>3</sup> Sic Ms., Obara. occidentem.

<sup>4</sup> Sic Ms., Obara sentitur.

<sup>5</sup> Correximus ex Ms. Obara Ecniphia.

<sup>6</sup> Correximus ex Ms. Obara Ecniphia.

<sup>7</sup> Sic Ms., Obara procellam.

<sup>8</sup> Sic Obara, Ms. subvertitur.

<sup>9</sup> Inseruimus, omisit Ms. Obara.

The answer is that this can happen for triple reasons, either because that direction abounds with very many exhalations that are suited due to the temperance of air with the result that they are converted into winds, or because, when the wind blows for example from the east, the said exhalations are received in the west, which, when they find the western part to be filled with other exhalations, return again to the eastern direction, having been propelled by them, or thirdly on account of some peculiar influence of heat, which on account of the diverse disposition of earth, receives its effect in one place more than another, and causes winds.

### **On hurricane, typhoon, and firestorm**

A hurricane or stormy wind, which is also called storm, is made in the manner of a thunderbolt, except that the exhalation, surrounded by vapor or cloud, is thicker and less viscous, and accordingly it happens that it sometimes burns up; and so when this exhalation, surrounded by a cloud, is forced by the coldness of the very cloud or the middle [f.35v.] region of air with great force downwards, a hurricane or storm is brought up; and it is a wind so very vehement in many cases that ships are capsized very quickly, unless the sails are shortened; for this reason sailors under the equinoctial line, where this happens rather frequently, take great care so that, as soon as a stormy cloud appears, they bring the sails down; out of this cloud hot water rains down, from which worms suddenly are born, and clothes, which the water covers, become rotten, and it raises vesicles in the flesh.

Typhoon or whirlwind comes into being out of the fact that exhalations are forced by diverse clouds or by diverse parts of the same cloud into opposing directions, out of which hurricane is generated; these exhalations, however, or hurricanes, coming together into one place, and struggling to go over into opposing directions, fight among each other;

cumque altera<sup>1</sup> alteram superat, ea quae superatur, insequuntur se secundum latus atque ita pugnantes ad terram perveniunt circulariter motae,<sup>2</sup> paleasque et pulverem circulariter gyrant, reflectuntur iterum a terra<sup>3</sup> sursum per aliquam distantiam. In locis etiam angustis solent turbines fieri et in fluviis vortices propter aquae reflectionem ratione loci, per quem aqua defluit; habentque tantam vim hi<sup>4</sup> turbines, ut magna corpora circumferant, sicut naves in mare et lapides et arbores in terra; quod si aliquando contingat exhalationes seu turbines inflammari, fiunt presteres, quae nihil aliud sunt quam ecnephiae vel turbines inflammatae.<sup>5</sup>

### **De hiatu, voragine, et variis coloribus, qui in aere, et astris conspiciuntur**

Supradicta fiunt hoc modo: solent exhalationes calidae et siccae illustrari nocte serena lumine lunae aut aliorum astrorum, quae si in medio densiores sunt et in extremis rariores, illud medium propter densitatem minus illustrarum est, et ideo apparet profunditas quaedam, quae si magna videatur dicitur vorago, si minor<sup>6</sup> dicitur hiatus. Causa huius est, quia partes extremae et rariae illustratae apparent candidae, media vero pars densior apparet nigra; candidus autem color, quia plus luminis in se recepit, magis aspectum movet et propinquior apparet, niger autem distantior, quia minus luminis recipit, quamvis uterque sit aequae propinquus; hinc enim fit, ut pictores, cum aliquid cavum aut profundum remotumque a nobis, ut puteum aut antrum, pingere volunt, colore nigro aut caeruleo utantur, albo seu splendido circa nigrum adhibito,<sup>7</sup> et cum aliquid propinquum aspectus depinguunt, albo eique affinibus<sup>8</sup> [f.36r.] coloribus id effingunt,<sup>9</sup> id vero, quod ambit, nigro aut caeruleo colore depingunt.

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<sup>1</sup> Ms. \altera/.

<sup>2</sup> Sic Ms., Obara moto.

<sup>3</sup> Ms. ter-~~ra~~.

<sup>4</sup> Sic Ms., Obara hae.

<sup>5</sup> Sic Ms., Obara inflammatae.

<sup>6</sup> Ms. min~~us~~\ot/.

<sup>7</sup> Sic Ms., Obara adhibitur.

<sup>8</sup> Sic Ms., Obara affinibus [f.36].

<sup>9</sup> Correximus ex Ms. Obara effingunt.



and when one of them overcomes the other, the ones which are overcome pursue themselves along the side and so, fighting, they come to the ground, being moved around in a circular motion, and they whirl chaff and dust in a circular motion, [and] are turned back from the ground again upward over some distance. Also, in crowded places whirlwinds are accustomed to happen as are whirlpools in rivers due to the turning back of water because of the way the place is, through which the water flows down; and these whirlwinds have such force that they carry around large bodies, such as ships on sea and rocks and trees on land; but if it should happen sometimes that exhalations or whirlwinds are put on fire, firestorms happen, which is nothing other than hurricanes or whirlwinds on fire.

**On *hiatus*, *vorago*, and various colors which are seen in the air and stars**

The abovementioned things are made in this way: Hot and dry exhalations are accustomed to be illuminated in a serene night by the light of the moon or of other stars, and if they are thicker in the middle and thinner at the ends, that middle, due to its thickness, is less illuminated, and for that reason a certain hole appears, which if large in appearance is called a *vorago*, if smaller, it is called a *hiatus*. The cause of this is because the thinner parts at the end, when illuminated, appear bright white, but the middle thicker part appears black; a bright white color, moreover, because it received more light in itself, affects the sight more and appears to be closer, and the black color on the other hand [appears] more distant, since it receives less light, even though both may be equally close; for hence it happens, that painters, when they wish to draw something concave or deep and remote from us, such as a well or a cave, use a black or dark blue color, applying a white or bright color around the black, and when they paint something close in sight, they draw it with a white [f.36r.] color or colors close to it, but they draw that which surrounds it with a black or dark blue color.

Apparent etiam in aere varii colores; nam si exhalatio expansa in medio aeris non sit adeo densa, ut illuminata appareat nigra, neque adeo rara, ut candida videatur, solet videri rubea; similis color apparere solet in ortu vel occasu solis<sup>1</sup> vel lunae; tunc enim aer interpositus<sup>2</sup> inter nostrum aspectum et astra multis exhalationibus refertus est, nec valde densis, nec valde raris, per quas radii solis et lunae transmissi efficiunt colorem apparentem. Idem contingit, si per fumum sol aut luna conspiciatur;<sup>3</sup> ut enim lux per vaporem transmissa solet colorem caeruleum apparentem efficere, sic etiam lux transmissa per exhalationem neque valde raram neque valde densam solet efficere colorem rubeum apparentem; hic est quod, cum occasus rubet sole occidente, significat siccitatem et +non vacuum ventorum<sup>4</sup>+ propter exhalationum calidarum et siccarum abundantiam<sup>5</sup>: quando vero occasus occidente sole caeruleus est, significat humiditatem et pluviam propter abundantiam vaporum; denique astra visa per medium rubeum solent apparere rubea, sicut res visa per vitrum apparet eius coloris, qui est in vitro, propterea quod species defertur ad oculum affecta colore medii.

### De halone et iride

Halo est circulus quidam lucidus, qui frequentius apparet sub luna, raro sub sole, et rarius adhuc sub<sup>6</sup> aliis astris; fit autem ex eo, quod in vapore constante partibus aequalis raritatis ac densitatis positoque inter astrum et nostrum aspectum refringuntur radii astri propter aequalem densitatem vaporis, neque sinuntur progredi recte; ex refractione uniformi illorum radiorum ad latera vaporis causatur circulus ille; est autem signum pluviae, quia vapor ille paulatim condensatur in nube, quando vero dissipatur, signum est venti, et quando emarcescit,<sup>7</sup> signum est serenitatis.

Iris fit ex refractione radiorum solis ad nubem roridam, apparet vero mane versus occidentem et vesperi versus orientem; fit autem aliquando (licet raro) ex radiorum refractione lunae, cum est plena. In iride tres potissimum<sup>8</sup> colores apparent, scilicet puniceus, viridis et purpureus; diversitas autem huiusmodi colorum a quibusdam dicitur provenire ex varia dispositione nubis, a quibusdam vero ex parte radiorum reflexorum,<sup>9</sup> qui qui quo longius protrahuntur, eo debiliores sunt, causantque [f.36v.] apparentiam eius coloris,<sup>10</sup> qui magis vergit ad nigrum; solent quoque apparere duae et aliquando tres.

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<sup>1</sup> Ms. solis &.

<sup>2</sup> Sic Ms., *Obara* intrapositus.

<sup>3</sup> Sic Ms., *Obara* conspiciatur.

<sup>4</sup> Ms. non vacuum ventorum, *Obara* numquam velant ventos [sic!].

<sup>5</sup> Ms. \*significat...abundantiam\*. *Fortasse alterius manus inter asteriscos.*

<sup>6</sup> *Correximus ex Ms. Obara* ab. Cf. Titelmans 1564, 159.

<sup>7</sup> Sic Ms., *Obara* emarcescit.

<sup>8</sup> Ms. potissimū., *Obara* potissimi.

<sup>9</sup> Ms. reflexorj.

<sup>10</sup> Sic Ms., *Obara* coloris.

In the air, too, various colors appear; for if the exhalation which has been spread out in the middle of air is not so thick, so as to appear black when illuminated, nor so thin, that it would appear white, it is accustomed to appear red; a similar color is accustomed to appear in the rise or fall of sun or of the moon; for at that time, the air interposed between our sight and the stars is filled with many exhalations, neither too thick, nor too thin, and when the rays of the sun and the moon are sent across them, they effect the visible color. The same thing happens if the sun or the moon is seen through a smoke, for just as light sent across vapor usually effects a color blue in appearance, so also light sent across exhalation that is neither too thin nor too thick is accustomed to effect a color red in appearance; here is the reason why, when the west is red when the sun sets, it signifies dryness and no lack of winds on account of the abundance of hot and dry exhalations, but when the west is blue when the sun sets, it signifies humidity and rain due to the abundance of vapors; and lastly, stars seen through a red medium usually appear red, just as a thing seen through glass appears to be of that color, which is in the glass, since the shape is carried to the eye affected by the color of the medium.

### **On halo and rainbow**

Halo is a certain bright circle, which more often appears under the moon, sometimes under the sun, and more rarely under other stars; it, however, arises from this fact, that in a vapor consisting of parts of equal thinness and denseness and positioned between a star and our sight, the rays of the star are refracted due to the equal denseness of the vapor, and are not allowed to proceed straight; that circle is caused by the uniform refraction of those rays to the side of the vapor; it is, however, a sign of rain, since that vapor is condensed little by little in a cloud, but when it dissipates, it is a sign of wind, and when it wanes away, it is a sign of serene weather.

The rainbow is made from the refraction of the rays of the sun towards a dewy cloud; it appears indeed in the morning towards the west and in the evening towards the east; it is also made (though rarely) from the refraction of the rays of the moon, when it is full. In a rainbow, three colors are apparent most of all, namely red, green, and purple; this kind of diversity of colors is said by some to come from the various disposition of the cloud, but by others [it is said to come] from a part of the reflected rays, which become weaker the longer they are dragged out, and cause [f.36v.] the appearance of that color, which verges more toward black; and they are accustomed to appear in twos and sometimes threes.

### De virgis et pareliis

Virgae generantur hoc modo: aliquando ad latus solis est nubes deformis<sup>1</sup> habens quasdam partes densiores aliis, et quasdam facile resolubiles in aquam, quasdam vero difficile; haec autem nubes penetrata a radiis solis propter diversitatem suarum partium apparet diversis coloribus ornata, cumque extensa est<sup>2</sup> perpendiculariter a media regione aeris versus terrae superficiem, apparent in ipsa virgae diversorum colorum.

Parelia<sup>3</sup> fiunt, cum nubes diaphana et aliqua ex parte terminata opaca et uniformis posita fuerit non sub sole, neque ex opposito, sed<sup>4</sup> ad eius latus iamiam parata, ut in pluviam vertatur; in illa solet imprimere sol suam imaginem per radiorum refractionem, sicut in speculo; dictum est nubem debere esse aliqua ex parte terminatam et opacam, ut ab ea possit fieri reflexio<sup>5</sup> specierum ad nostrum oculum; debet quoque esse uniformis, ut perfectior solis imago imprimatur, debet esse iam parata, ut in pluviam vertatur, ut commodius in ea<sup>6</sup> repraesentetur solis imago, sicut in aqua pellucida; nondum tamen debet debet esse versa in aquam, quia non esset terminata, et proinde non posset solis imaginem exprimere. Interdum solent esse duae huiusmodi nubes iuxta solem, una ex hoc latere et altera ex alio, quo modo videntur esse tres soles, unus verus et duae imagines ipsius.

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<sup>1</sup> *Coniecimus ex diformis. Sed fortasse legendum est biformis.*

<sup>2</sup> *Addidimus.*

<sup>3</sup> *Ms. Obara pareleae; cf. Titelmans 1564, 161 [parahelius].*

<sup>4</sup> *Ms. ~~sed~~/sed/.*

<sup>5</sup> *Ms. refrexio.*

<sup>6</sup> *Inseruit Obara.*

### **On streaks and parhelia**

Streaks are generated in this manner; sometimes to the side of the sun there is a deformed cloud having certain parts that are denser than others, and certain parts that are easily resolved into water, but other parts that are [resolved into water] with difficulty; this cloud, penetrated by the rays of the sun, appears embellished with diverse colors due to the diversity of its own parts, and when it is extended perpendicularly from the middle region of air towards the surface of earth, in it appear streaks of diverse colors.

Parhelia take place, when a cloud that is diaphanous, and bordered to a certain degree, opaque and uniform, should be placed not under the sun, and not on the opposite side, but next to it, about ready to be turned into rain; on it the sun is accustomed to impress its own image through the refraction of rays, just as on a mirror; it has been said that the cloud ought to be bordered to a certain degree and opaque, so that a reflection of shapes should occur from it toward our eye; it also ought to be uniform, so that a more perfect image of the sun be impressed, it ought to be already ready to be turned into rain, so that the image of the sun should be represented in it more conveniently, just as on pellucid water; but it should not yet be turned into water, because [otherwise] it would not be bordered, and would accordingly not be able to express the image of the sun. Sometimes two such clouds are next to the sun, one on one side and another on the other side, with the result that there seem to be three suns, one of them genuine and two that are its images.

## § 4.

**De impressionibus aqueis terrestribus****De origine fontium<sup>1</sup>**

De fontium ac fluviorum origine ait Aristoteles lib. 1, c.13, relicta hoc loco opinione Platonis existimantis in centro terrae esse aquarum multitudinem maximam, ex qua flumina omnia et ipsum quoque mare ortum habeat, rursusque in eundem locum redire; quam Aristoteles lib. 2. c. 2 refutat.<sup>2</sup> Alii, quorum sententiam refert Aristoteles lib. 1. cap. 13,<sup>3</sup> existimarunt, quemadmodum in exteriori parte terrarum vastae paludes iacent, magnique et navigabiles<sup>4</sup> lacus, sic inferiora terrarum aquis dulcibus abundare; dicunt enim enim alveos et concavitates intra illam contineri, in quas imbres recipiantur, deinde vero ex hac profunda copia aquarum flumina et fontes effluere; ideo hieme, qua imbres frequentiores et ampliores esse solent, maiores fluvios<sup>5</sup> quam ante exire, et quod alii aliis [f.37r.] alveis maiores sunt et potentiores fieri, ut alii perenniter fluant, alii deficiant; perenniter quidem eos fluere, quorum aqua ab alvei magnitudine adeo multa est, ut usque ad hiemem futuram sufficiat, nec antea exsiccet, quam illa redierit; eos vero siccari, qui ex alveis minoribus egrediuntur. Verum his opinionibus omissis, sententia Aristotelis est flumina ex fontibus originem ducere, fontes autem ex vaporibus et aere, qui in poris et cavernis terrae includuntur, ubi frigiditate loci refrigerantur, densantur, et in aquam convertuntur, itaque in poris atque concavitatibus montium aer et vapores perpetuo recipiuntur, ne detur vacuum; et ibi in guttulas aquae convertuntur, quas terra multis in locis stillat, deinde ex illis ob gravitatem descendentes atque in unum locum coeuntibus emergunt fontes; unde flumina ex montibus fluunt et eorum maxima ex maximis et altissimis montibus; fontes item magna ex parte locis excelsis propinqui sunt, in planis autem pauci admodum, et illi quidem sine fluviis, qui ab illis fluant; montosa autem et alta loca quasi spongia suspensa paulatim quidem, sed multis in locis stillant.

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<sup>1</sup> Sic Obara, Ms. §/ ~~De origine fontium~~ / De impressionibus aqueis terrestribus -/ De origine fontium.

<sup>2</sup> Arist. *Mete.* 355b33-356a33.

<sup>3</sup> Arist. *Mete.* 349b2-15,

<sup>4</sup> Ms. ~~navi~~ navigabiles.

<sup>5</sup> *Correximus ex Ms.* fluvius, Obara fluvii.

**§ 4.****On watery impressions on earth****On the origin of springs**

On the origin of springs and rivers, Aristotle speaks in book 1, chapter 13; omitting at this place the opinion of Plato, who thought that there was a very great multitude of waters in the center of earth, from which all rivers and the very ocean as well have their origin, and that they went back to the same place; which Aristotle refutes in book 2, chapter 2. Others, whose opinion Aristotle reports in book 1, chapter 13, have thought that, just as vast marshes and great and navigable lakes lie on the exterior part of earth, so the lower parts of earth abound in fresh waters; for they say that riverbeds and concavities are contained therein, into which rains are received, and that out of this deep supply of waters rivers and springs then flow out; that, for this reason, during winter, when rains are accustomed to be more frequent and ample, rivers flow in greater quantities than before, and it happens hence that some rivers [f.37r.] are greater and more powerful than others, so that some flow perennially, and some cease; that those rivers to be sure flow perennially, whose water is so great from the magnitude of the channel, that it would last into the coming winter, and does not dry out before it returns; those, however, become dry, which come out of smaller channels. But omitting these opinions, Aristotle's opinion is that rivers draw their origin from springs, springs on the other hand from vapors and air, which are shut inside pores and caverns of the earth, where they are made cold by the coldness of the place, and made dense, and are converted into water; and so in the pores and concavities of mountains air and vapors are continuously received, so that there should not be a vacuum; and there they are converted into drops of water, which the earth drips in many places, and then from these, which descend due to their heaviness and come together in one place, springs emerge; whence rivers flow out of mountains, and the greatest of them from the greatest and tallest mountains; likewise, springs for the most part are next to high places, in plains, however, there are very few of them, and to be sure these are without rivers which flow from them; however, mountainous and high places, like a suspended sponge, drip, little by little to be sure, but in many places.

Sed est argumentum desumptum ex primo capitulo *Ecclesiastes*, ubi legitur: Omnia flumina intrant in mare et mare non redundat, ad locum unde exeunt revertuntur, ut iterum fluant; propter quam auctoritatem quidam probabiliter putant flumina originem ducere a mari per poros terrae;<sup>1</sup> quae enim causa est, ne fontes et flumina sint salsa, quia salsedo relicta fuit in terra. Haec opinio probabilis est, verum prima est probabilior; et ideo ad auctoritatem Sanctae Scripturae respondeo verissimam<sup>2</sup> esse, nam mare est primum principium, unde educti fuerunt vapores per agentia naturalia, et ex illis fiunt fontes et flumina, quae revertuntur ad ipsum mare; verum immediate fontes et flumina fiunt sicut dictum est in prima opinione; praeterea non videtur esse verum, quod tanta copia aquae possit ascendere ex mari ad altissimos montes, ut inde emanent maxima flumina, quae sunt in mundo, praesertim cum illa opinio, quae dicit montes altiores esse mari, sit probabilior quam contraria. Quare opinio Aristotelis magis conformis est rationi.

### De fluxu et de<sup>3</sup> refluxu maris

Sententia communis est lunam esse causam fluxus et refluxus maris, quia luna, ut multis experimentis compertum est, dominatur rebus humidis, ac proinde mari; item fluxus et refluxus maris sequuntur cursum lunae; ipsa enim supra horizontem ascendit vel intumescit mare, qui tumor semper [f.37v.] sequitur lunam, et eius punctum oppositum; itaque si luna sit in nostro meridiano, mare tumidum est et plenum in eodem loco et in antipodis; in puncto vero orientis et occidentis mare refluxum est (ut dicunt) et vacuum; incrementa vero illa et decrementa, quae nostri appellant ‘aguas mortas,’ lunae quoque adscribenda sunt; in novi- enim et plenilunio fiunt maxima incrementa, quia tunc luna est in tali aspectu cum sole et aliis astris, ut maxime iuventur ad fluxum et refluxum maris. Ex dictis videtur sequi mare semper fluere ab oriente versus occidentem sequens ipsam lunam, verum experientia nautarum compertum est fluxus aquarum communiter sequi motionem ventorum, quae vulgo dicuntur ‘monsan,’ quae non impedit tumorem factum a luna; huius rei causa nondum bene comperta est, effectus vero notus est; nam licet ventus remissus sit, si navis sequatur fluxum maris, qui dicitur ‘corrente das aguas,’ brevi conficit magnum iter; et si contra cursum aquarum viam agat, maxime impeditur, licet iuvetur<sup>4</sup> a vento; igitur et iste fluxus sive ‘correntes’ feruntur in varias partes horizontis secundum dispositionem sinus terrarum; item nondum comperta est causa, cur Mare Mediterraneum non intumescat, licet aliqui dicant, illud esse<sup>5</sup> angustum et ideo non posse lunam<sup>6</sup> illud elevare, quia eius vis parum supra ipsum detinetur, cum sit circumdatum terra ad modum paludis, et intra se multas et magnas contineat insulas.

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<sup>1</sup> OT *Eccl.* 1.7.

<sup>2</sup> *Sic Ms., Obara* verissimum.

<sup>3</sup> *Sic Ms, omisit Obara.*

<sup>4</sup> *Correximus ex Ms. Obara* iuvatur.

<sup>5</sup> *Correximus ex Ms. Obara ...illud non esse...*

<sup>6</sup> *Correximus ex Ms. Obara* luna. *Sed fortasse* luna illud elevari.



But there is an argument taken from the first chapter of *Ecclesiastes*, where one may read: All rivers enter the sea and the sea does not flow back, they return to the places from where they go out, to flow again; because of this authority, some reasonably think that rivers draw their origin from the sea through pores of the earth; for this is the reason why springs and rivers are not salty, because the saltiness was left in the earth. This opinion is probable, but the first is more probable; and thus, as for the authority of the Sacred Scripture, I answer that it is most true, since the sea is the first principle, whence vapors were led out through natural agents, and out of these, springs and rivers are made, which return to the very sea; but springs and rivers are made without intermediaries, as was said in the first opinion; besides, it does not seem to be true, that such a great supply of water could ascend from the sea to the highest mountains, so that the greatest rivers, which are in the world, should flow out of them, especially since that opinion, which says that mountains are higher than the sea, is more probable than the contrary one. For this reason, the opinion of Aristotle conforms to reason more.

### **On the flow and ebb of the sea**

The common opinion is that the moon is the cause of the flow and ebb of the sea, since the moon, as is ascertained by many experiments, dominates humid things, and so accordingly, the sea; likewise the flow and ebb of the sea follow the course of the moon; for it ascends above the horizon or the sea grows big, and this tumor always [f.37v.] follows the moon, as well as its opposite point; and thus, if the moon is in our meridian, the sea is big and full in the same place and in the antipodes; but in the eastern and western point, the sea is in an ebb (as they say) and empty; those increases and decreases, which our people call *aguas mortas*, are also to be ascribed to the moon; for in the new and full moon the greatest increases happen, since at that time the moon is in such an aspect with the sun and other stars, so that they receive the most help for the flow and ebb of the sea. From what has been said, it seems to follow that the sea always flows from east to west following the very moon, but by the experience of sailors it has been ascertained that the flow of waters commonly follows the motion of the winds, which are called *monsan* in the vernacular, which does not impede the tumor made by the moon; the cause of this thing has not yet been well ascertained, but the effect is known; for even though the wind may be slack, if a ship follows the flow of the sea, which is called *corrente das aguas*, it completes a great journey in a short time; and if it takes a path against the course of the waters, it is impeded greatly, even though it may be helped by the wind; thus that flow or *correntes* also rush into various directions of the horizon according to the disposition of the bays of the lands; likewise the reason has not yet been well ascertained why the Mediterranean does not grow big, although some say that that sea is small and for this reason the moon cannot elevate it, since its force does not stay above it with sufficient strength, as it is surrounded by land like a marsh, and it contains many large islands within it.

### De salsedine maris

Mare creatum fuit a Deo Optimo et Maximo ita salsum, ut modo est; causa vero naturalis eius salsedinis est permixtio exhalationum adustarum cum aqua, quae reddunt ipsam salsam, sicut patet in lixivio, quod salsum est, quia aqua per<sup>1</sup> cineres adustos colatur, et cum eo permiscentur partes adustae; similiter sudor et lacrymae salsa sunt, quia habent permixtas partes siccas et adustas; item fontes transeuntes per terram adustam ut sulfuream salsi sunt; et ideo mare salsum est, quia habet exhalationes permixtas, quod probatur, quia aqua maris est ceteris calidior propter exhalationes adustas; item si aqua<sup>2</sup> maris per terram coletur aut per ceram, amittit salsedinem, quod propterea fit, quia exhalationes non percolantur, sed sola aqua; item aqua maris crassior et gravior est aqua dulci, cum naves plus mergantur in aqua dulci quam in mari, et ova in aqua salsa supernatent, et non in dulci;<sup>3</sup> huius causa est, quia mare habet multas exhalationes permixtas, scilicet terrestres; flumina vero non sunt salsa, quia paucas habent exhalationes, cum continuo succedat nova aqua dulcis; nec [f.38r.] pluvia est salsa, quia elevantur vapores sine exhalationibus terrestribus, ut<sup>4</sup> apparet et videtur in vaporibus, qui elevantur in olla<sup>5</sup> ex aqua sale permixta permixta.

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<sup>1</sup> Sic Ms., omisit Obara.

<sup>2</sup> Ms. aqua~~am~~.

<sup>3</sup> Correximus ex Ms. inducit, Obara [?] sit.

<sup>4</sup> Correxit Obara ex Ms. et.

<sup>5</sup> Ms. \in ola/.

**On the saltiness of the sea**

The sea was created by God the Best and Greatest just as salty as it now is; but the natural cause of its saltiness is the mixture of burned exhalations with water, which make it salty, just as is evident in lye, which is salty, because water is percolated through burnt ashes, and burnt parts are mixed with it; similarly sweat and tears are salty, because they have parts that are dry and burnt mixed; likewise springs going through burnt earth, such as a sulfurous one, are salty; and the sea is salty for this reason, that it has mixed exhalations, which is proven, as the water of the sea is hotter than the rest on account of burnt exhalations; likewise if seawater is percolated through earth or through wax, it loses its saltiness, which happens for this reason, that the exhalations are not percolated, but only water; likewise seawater is thicker and heavier than fresh water, as ships sink in more on fresh water than on the sea, and eggs float on salty water, and not on fresh water; the reason for this is that the sea has many exhalations that are mixed in, namely earthly ones; rivers, however, are not salty, since they have few exhalations, as new fresh water is added continuously; nor [f.38r.] is rain salty, since vapors rise without earthly exhalations, as it appears and is seen in vapors, which rises in a pot from water mixed with salt.

### De terraemotu

Terraemotus fit hoc modo: Virtute solis et aliorum astrorum generantur plurimae exhalationes in concavitatibus terrae, quae ita inclusae egredi nequeunt, eo quod terra nimis compacta sit ob frigiditatem circumstantem aut pluviam praecedentem, exitumque petentes terram concutiunt, et ita terraemotum efficiunt; qui si in latus fiat, tremor dicitur, si vero elevatio fit collis in altum, dicitur pulsio; quo terraemotu contingit civitates opprimi, sicut contigit Arequipae<sup>1</sup> civitati Peranae annis 1579. Fiunt etiam montes aut evertuntur. Tremor autem frequentior est quam pulsio, habetque durationem iuxta exhalationum magnitudinem et firmam solidamque terrae compactionem. Signa futuri terraemotus sunt, si mare nullo vento spirante subito intumescat, et si aquae in imo puteo turbulentae sint; interdum vero solet cum terraemotu egredi flamma, aut quia exhalatio magno impetu egrediens inflammatur, aut quia in visceribus terrae continetur aliqua pars sulfurea terrae, quae simul cum exhalatione per motum illum inflammatur; quandoque accidit, ut cum terraemotu tanta cinerum copia egrediatur, ut agros operiat, ut contigit in insulis Tertiariis anno 1580 et alibi saepe; non quod cineres tum generantur, sed ibi relictis sunt ab inflammatione sulfuris in dictis ardentis, qui postea pelluntur motu terrae facto; in quibus locis frequenter fiunt terrae motus propter vim ignis, qua etiam ratione pulvis sulfureus turribus suppositus et incensus eas<sup>2</sup> evertit sursumque pellit. [finis]

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<sup>1</sup> *Correximus ex Ms. Aliquippe, Obara aliquippe.*

<sup>2</sup> *Sic Ms., Obara eos.*

### On earthquake

An earthquake happens in this way: By the power of the sun and of other stars, very many exhalations are generated in the concavities of the earth, which, shut in in this way, cannot go out, for the reason that earth is packed too solidly on account of the surrounding coldness or of a preceding rain, and, seeking an exit, they shake the earth, and so effect an earthquake; which, if it happens to be lateral, is called *tremor*, if on the other hand there is an elevation of a hill upwards, it is called *pulsio*; by this [kind of] earthquake, it happens that cities are crushed, as it happened in Arequipa, a Peruvian city, in the year 1579. Mountains are also made or overturned. *Tremor* is more frequent than *pulsio*, and has duration in proportion to the magnitude of the exhalations and the firm and solid compacting of the earth. Signs of a future earthquake are, if a sea, with no wind blowing, suddenly grows big, and if waters in the bottom of a well are turbulent; sometimes indeed a flame is accustomed to come out with an earthquake, either because an exhalation, coming out with great force, is put on fire, or because in the innards of the earth is contained some sulfurous part of earth, which together with the exhalation is put on fire through that motion; and it sometimes happens, that with an earthquake, such a great amount of ashes comes out that it covers fields, as happened in the Azores in the year 1580 and often in other places; not that ashes are generated at that time, but they are left there by the burning of the sulfur which was on fire in the said places, and it is afterwards pushed out when the earthquake happens; in these places earthquakes often happen due to the force of the fire, by which reason also sulfurous powder, placed under towers and put on fire, overturns them and pushes them upwards. [finis]

**Appendix: Titles of chapters and sections of Book 6 and 7 in Titelmans' *Compendium philosophiae naturalis* (Titelmans 1564, pp. 146-224)<sup>1</sup>**

**Liber VI De mixtorum imperfectorum generationibus**

Praefatio

Cap.1 De tribus aeris regionibus, earumque dispositionibus diversis.

Cap.2 Quid actio per antiperistasin, et quomodo per talem actionem media aeris regio sit multum frigida.

Cap.3 De ijs quae in suprema aeris regione generantur.

Quid vapor et exhalatio / Quid vorago / Quid hiatus

Cap.4 De generatione cometae.

Cap.5 De galaxia, sive via lactea.

Quid circulus lacteus / Galaxia elementaris

Cap.6 De ijs quae in media et infima aeris partibus generantur, pluvia, grandine, nive, pruina et nebula.

Pluvia / Nix / Ros / Pruina / Caligo / Pruina [sic]

Cap.7 De fontium et fluviorum generatione.

Cap.8 De maris salsedine, eiusque fluxu et refluxu.

Cap.9 De ventis et eorum generationibus, atque diversitatibus.

Cap.10 De terraemotu.

Cap.11 De tonitruo et fulmine.

Quid fulmen et tonitruum / Nota de fulmine / Visus anticipat auditum

Cap.12 De halone, sive corona.

Halon sub sole, luna et astris

Cap.13 De generatione iridis

Iris tricolor / Quomodo simul plures irides videri contingit

Cap.14 De parahelijs.

Parahelium quid

Cap.15 Differentia parahelij ab halone et iride

**Liber VII Considerationes physicae de coelo et mundo**

Praefatio

Cap.1 Quaedam divisiones et definitiones sequentibus necessariae.

Cap.2 De totius universi dispositione et ordine omnium quae sunt in eo.

Quinque gradus mixtorum corporum

Cap.3 De elemento ignis specialis determinatio.

Ignis elementaris maxima raritas

Cap.4 De situ elementi aquae et terrae discoopertione.

Nota: firmiorem rerum naturalium quam hominis obedientiam

Cap.5 De terrae immobilitate et minima quantitate.

Terra centrum mundi / Nota: magnitudinem stellarum firmamenti

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<sup>1</sup> Titles of sections here are those shown in the margin of each page in this edition.

Cap.6 Unde terra habeat suam immobilitatem atque firmitatem.

Cap.7 De terrae rotunditate et montium elevatione in terra.

Quare deus in terra montes et valles constituit / Terrae magnitudo / 252000 / 180000

Cap.8 Unde ordo in elementorum situ.

Cap.9 De differentia naturae et regionis coelestis ab elementari.

Lux nobilis qualitas / Coelum quintam essentiam dixerunt

Cap.10 Unde habeant coelestia corpora motum circularem et an naturaliter moveantur.

Cap.11 Coelestia corpora an dici debeant animata.

Differunt angelus et anima hominis

Cap.12 De divisione regionis coelestis secundum suos orbis.

Prima opinio de numero coelorum / secunda opinio / Nonum coelum ratione inventum

Tertia et probabilior opinio / Motus trepidationis

Cap.13 De coelo empyreo et de coelo crystallino sive aqueo ac primo mobili.

Coelum empyreum / Coelum nonum

Cap.14 De firmamento et orbibus planetarum.

Orbes septem planetarum

Cap.15 De duplici motu orbium coelestium, qui sunt post primum mobile.

Quis dies naturalis / Quis artificialis dies / Duo poli mundi / Quid axis mundi / Motui raptus motus adversus

Cap.16 Quomodo intelligi debent in coelis motus oppositi et motus raptus.

Cap.17 Quanto tempore unusquisque coelestium orbium suum proprium motum compleat et obiter de anno bissextili.

Coelum crystallinum / 49000

Cap.18 De natura et conditionibus astrorum.

Cap.19 Differentia inter planetas et stellas fixas.

Soli planetae non scintillant

Cap.20 De ordine septem planetarum adinvicem.

Ordo planetarum probatur

Cap.21 De planetarum distinctione.

Saturni qualitas / Iupiter / Martis qualitas / Attende: mirum in planetis ordinem

Cap.22 De venere, mercurio et luna.

Vergilius / Mercurius / Luna

Cap.23 De solis nimia praecellencia super caeteros planetas.

Solis praecellencia / Omnium stellarum lumen a sole esse / Quorundam opinio / Venus est soli quasi pro coniuge / Calor solis differt a calore martis

Cap.24 De sole in sacris literis quam honorifica fiat mentio.

Franciscus quomodo solem magnificabat

Cap.25 De circulis maioribus et primum de aequinoctiali.

Aequator / Cingulum primi mobilis

Cap.26 De circulo zodiaco et signis eius.

Omnes planetae sub zodiaco motum absolvunt / Linea ecliptica

Cap.27 De coluris Solstitiorum et aequinoctiorum.

Solstitiorum distinctio / Aestiuum solstitium / Hyemale solstitium / Aequinoctiorum distinctio / Aequinoctium vernale / Aequinoctium autumnale

Cap.28 De meridiano et horizonte.

Meridianus / Zenith / Nadir / Horizon

Cap.29 De circulis arctico, antarctico, tropico Cancrini et tropico Capricorni.

Circulus arcticus et antarcticus / De duobus tropicis / Cur tropici dicantur

Cap.30 De quinque zonis sive plagis.

Torrada zona / Regiones frigidissimae / Regiones temperatae

Cap.31 De eclipsi lunae, quomodo et quando fiat.

Caput et cauda draconis opposita / Quomodo lunae fit eclipsis

Cap.32 Nunquam fieri eclipsim lunae, nisi tempore oppositionis.

Quare non semper fit in oppositione eclipsis

Cap.33 Quod aliquando fieri possit eclipsis lunae partialis.

Cap.34 De eclipsi solis, quando et quomodo fiat.

Quomodo sol eclipsatur

Cap.35 Multiplex differentia inter eclipsim solis et lunae.

Eclipsis solis nunquam est universa

Cap.36 De novilunio et plenilunio

Novilunium / Quid plenilunium

Cap.37 De eclipsi facta tempore passionis Christi.

Dionysius Areopagita eclipsim advertit in passione Christi / Quinque miracula in una eclipsi

Cap.38 Quod eclipsis ista tempore passionis fuerit universalis.

Dionysij memorabile dictum / Eusebius / Phlegon

Cap.39 Solutio cuiusdam objectionis et libri conclusio.

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