PHILOSOPHICAL TRANSACTIONS.

May 25. 1674.

The CONTENTS.

Some Observations and Experiments about Vitriol, *tending to find out the nature of that substance, and to give further light in the Inquiry after the Principles and Properties of other Minerals: Communicated by a Fellow of the* R. Society, *who maketh use of Chymistry chiefly as subservient to Physiology.*

VITRIOL is by the Spagyrical Tribe reputed one of the chief Pillars of Medicine and Alchimy; and is indeed endowed with many excellent and truly admirable properties; being employed by Nature in her most Curious Mineral operations. 'Tis it self one of the most noble and useful

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productions, and therefore deſerves our eſpecial Conſideration. I do not pretend to render a Mechanical account of its generation, nor a hiſtory of all that may be performed by its mediation in Medicine or Chymiſtry; my deſign is only to furniſh Inquiſitive perſons with ſome Obſervations and Experiments, which will probably enable them more eaſily to inveſtigate the Nature of this *Protean* ſubſtance, as alſo afford ſome further light unto them in their Inquiry after the Principles and Properties of other Minerals. *Vitriol* is of ſeveral kinds, being, for colour, White, Yellow, Green, or Blew; uſually, of the two laſt mentioned: And is made *either* of Mineral Waters, boyled up to a convenient conſiſtence; then ſet to Chryſtallize: *Or* extracted by Common Water out of Earths impregnated therewith. 'Tis alſo afforded by many ſorts of Stones, commonly called *Pyrites* and *Marcaſites*, which expoſed ſome Months unto Aerial influences, are reſolved into powder, and the Saline part diſſolved in Rain or other Water; then boyled and ſet to ſhoot, yields ſtore of Vitriol, eſpecially with the addition of Copper or Iron. It is often aſſociated with Earth and Stones, wherein Mettals are contained; and with many natural recrements of Mettals, ſuch as *Miſy*, *Sory*, *Chalcitis*; from which 'tis uſually ſeparable by the common method with Water; ſometimes not to be extricated until the Mineral be firſt calcined or burnt. It is alſo frequently found pure and perfect in the Caverns of the Earth, being an Efflorescence of ſeveral Minerals; and this is accounted by all Naturaliſts the beſt, both for Medicinal and Spagyrical uſes. *Laſtly*, It is copiouſly contained in common Mineral Sulphur, as I ſhall anon fully evince. Vitriol uſually accompanying moſt Mettals and Minerals, many do apprehend, it is alwaies one of their component principles, at leaſt, a neceſſary Cauſe of, or Agent in, their Production; which if meant of the Acidity or Saline part of Vitriol, ſeems highly probable; as I ſhall manifeſt at large in the enſuing diſcourſe. But firſt I think it expedient to examine, what are the conſtituent parts of Vitriol, whereby we ſhall be better enabled to judge of its nature and properties.

Vitriol conſiſts of Inſipid phlegme, Earth or Oker, ſome Mettal, Mineral Sulphur, an acid Salt or Spirit, together with

with ſome ſmall portion of the Volatil Aerial Salt.

That it contains *Water*, needs no great proof, ſince no Saline ſubſtance can cryſtallize without it; and diſtillation will convince any perſon, that it exceeds in quantity any of the other Principles.

The *Earth* or *Oker* may be thus ſeparated: Diſſolve Vitriol in fair water, immediately a yellow powder will ſeparate, and in a ſhort time ſubſide: The greater the quantity of water imployed, the more Oker precipitates: The weaker the *lixivium*, the leſs able to ſupport Bodies more ponderous than common water: And the lighter the Water (as if diſtilled rain-water, or phlegme of vinous Spirits,) the more Earthy parts ſubſide, upon the ſame Hydroſtatical principle I juſt now mentioned. I have above twenty times repeated this diſſolution, ſeconded by filtration and coagulation, and each time ſeparated ſome quantity of this Earth; and am perſwaded, had I long continued the operation, the ſucceſs would have been the ſame; only I obſerved the quantity ſeparated each time ſenſibly to diminiſh: And *Baſilius Valentinus* aſſures, that at length the Vitriol will let fall no more ſediment; and that then it is the ſubject of moſt noble operations by him particularized; which they who have leiſure, and confidence in his ſpecious promiſes, may do well to try. I have found a more eaſie and expedite way of effecting this ſeparation, which may be of great uſe to them who work on Vitriol, much abbreviate their labour, and conſiderably leſſen their expence.

Take a good quantity of the common, *Dantzick*, or *Hungarian*, Vitriol; having powdred it, put it into a ſlender Cucurbite, place it in Water, keep under it an equal conſtant fire three or four days: The Vitriol without additament will become fluid, as if diſſolved in water, and the Oker with moſt of the Metalline parts, with the groſs Sulphur, will ſubſide, and become a hard Cake at the bottom, the Vitriol being fluid above it, which in the cold again Cryſtallizeth; excepting a ſmall quantity of liquamen of the ſame nature with that we ſhall hereafter mention: This repeated once or twice, the Vitriol attains unto a high degree of purity, and is eaſily capable of many alterations, whereunto it was not ſubject be-

fore this purification. This operation will not ſucceed in a dry digeſtion; I mean, Aſhes, Sand, Filings of Iron, Steel, open Fire, or even flame of Lamps, whether fed with Oil or Spirit of Wine. This Earth may alſo be obtained in a great proportion, though in another form, if after a long and intenſe Calcination the Vitriol is freed from its remaining Salt by frequent ablutions with warm Water: The far greateſt part of this dulcified Colcothar is inſipid Earth with ſome ſmall proportion of Mettal. The ſame may be precipitated by Salt of Tartar, or any other Alcalies, or filings of *Zink*, or other immature Minerals, out of a ſolution of Vitriol in Common water: It being alſo ſeparated from Metalline and Saline parts, by a method I ſhall hereafter mention, there remains a great quantity of an inſipid ſubſtance nearly reſembling burnt Allom: Beſides, whereas *Salt*, *Nitre*, *&c.* require in diſtillation a larg quantity of Earthy ſubſtance to disjoyn the Saline parts, and prevent fuſion; Vitriol and Allom need it not; an unqueſtionable proof, that Earthy parts abound therein.

That Vitriol contains *Sulphur*, is evinced by the Sulphureous ſmell it emits in diſtillation, eſpecially if urged with a ſtrong fire from the beginning; and the Spirit thus drawn being rectified, the Liquor, which firſt ariſes, hath a highly Sulphureous ſmell, as hath alſo that we ſhall hereafter mention, diſtilled from Vitriol deprived of its Metallick parts. The *Colcothar* dulcified, or Metallick parts precipitated by an Alcali, or immature Mineral, ſublimed with Sal Armoniack, an inflammable Sulphur may be many ways ſeparated, both from the ſublimate and *Caput mortuum*. The Common Oil of Vitriol digeſted on Antimony, then diſtilled, yields a much greater quantity of Sulphur, than would have been produced, had any other acid liquor been imployed; and the ſame Oil of Vitriol digeſted with Spirit of Wine, and diſtilled, yields an Oil, and at the latter end ſtore of Sulphureous inflammable flowers.

As for the *Acid* Saline Principle, I ſuppoſe no perſon who hath taſted the Spirit of Vitriol, and that abuſively called, its Oil, will queſtion its abounding in that ſubject.

Some add unto the Principles, we have enumerated, the

Salt

Salt to be ſeparated from the *Colcothar* after diſtillation; which I omit, Experience having learned me, that it is of the ſame nature with the former, only ſomewhat more fixed; and if the Spirit be cohobated from the *Caput mortuum*, it is with the reſt volatilized, nothing remaining beſides Mettal and inſipid Earth.

The *Saline* Principle being that whereon I intend chiefly to inſiſt, I ſhall enquire whence it derives its Original? what ſubject it doth moſt reſemble? or with what 'tis moſt nearly allied? In order to the reſolution of theſe Enquiries, and the confirmation of certain Propoſitions, hereafter to be mentioned, I ſhall premiſe ſome Experiments, made many years ago, which perhaps may give no leſs ſatisfaction unto many of our Experimental Philoſophers, than they afforded me, when I firſt made mine.

I took four or five Gallons of the Vitriolate water, which was conveyed, by artificial Channels at *Deptford*, from the beds of *Pyrites* or *Marcaſites* into the great Ciſtern. I diſtilled therefrom in glaſs Veſſels two thirds of inſipid water; letting the Glaſſes cool, the water let fall a Vitriol of a lovely dilute Colour, (whether green or blewiſh I do not remember,) together with a great quantity of that yellow Sediment which we formerly called *Oker*: Then evaporating a third part of the remaining liquor, I received more Vitriol of a paler colour than the former, and *Oker* as before, though leſs: The fifth time this operation was repeated, inſtead of Vitriol it afforded a yellow, and ever after a white, Salt, which did differ exceedingly from Vitriol, not only in colour, but alſo taſte; being fiery and pungent; did partake little of that abominable rough aſtringent ſmack which is peculiar to Vitriol. It was alſo unctuous, like Salt of *Tartar*; made the hands ſoft and ſupple, cleanſing like a *Sapo*; whereas Common Vitriol renders them rough, and harſh: Being diſſolved in water, it appeared to the very Eye very fatty and oleaginous.

Among many other appearances ſufficiently remarkable, in this laſt Liquor and Salt, I ſhall only mention theſe few;

1. *Obſ.* From five pounds and a half of *Lixivium*, I received four pounds of this fiery white Salt, beſides half a pound

pound of *liquamen*, which remained fluid, and would not coagulate. I do the rather mention this; for that is one of the moſt eminent Inſtances, I ever met withal, of ſo great a quantity of Salt kept fluid in the cold by ſo ſmall a quantity of water.

2. The remaining *liquamen* was very fiery, acidly pungent, and extreamly ponderous; no whit inferiour, in my opinion, in any of theſe reſpects, to common Oil of Vitriol; it ſeeming to me ſtrange, and unuſual, that ſo ſtrong a liquor ſhould be obtained without any conſiderable degree of fire.

3. This *liquamen* being expoſed unto the Air, ſoon *attracted* (if our Criticks will permit me to uſe ſuch an expreſſion,) double its quantity of moiſture. I cannot recollect, that I did ever obſerve any fluid body, which approached near unto it for this property; though I am not ignorant, that all corroſive Saline liquors will borrow conſiderably from their neighbouring Element. And I remember, that divers eminent Chymiſts have delivered ſeveral preparations of Vitriol, which derive moiſture from the Moon more or leſs, according unto her ſeveral *Phaſes*; which I am perſwaded is a meer dream, having ſeen little hitherto that ſhould perſwade me, any of the Planets do influence otherwiſe than by heat and light. And I always obſerved this *liquamen* to acquire more or leſs moiſture, according to the Conſtitution of the Seaſon, riſing ſenſibly in moiſt weather, and little in dry, without any reſpect unto the Moon or other Planets; which I can the more poſitively determine, having for ſeveral Months made accurate obſervations with conveniently ſhaped Glaſſes. But to return from whence we digreſſed;

The white Salt laſt mentioned was diſtilled in a Sand-furnace, and the far greater part came over in the form of a Spirit highly acid, eſpecially that which came laſt in ſmall drops. This liquor rectified in a very tall body, immediately upon the approach of the ſmalleſt degree of heat a volatile Sulphureous Spirit did ariſe, clear as Rock-water almoſt, nay I think altogether inſipid; yet the ſmell ſo ſubtile and penetrating, that 'twas inſupportable: And ſuch it continued many years, not letting fall any ſediment, and thereby looſing its ſtrength, as doth the volatile Spirit made out of

Common

Common Vitriol. The Spirit which remained after the separation of the more volatil, was in all respects like that of *London* Vitriol; only seemed more gratefully acid, and might, like it, be separated into Spirit, and Oil, corruptly so stiled.

Vitriol freed, as is before declared, from its Earthy and Metallick parts, by *Zink*, or other imperfect Minerals, is much of the same nature, and yields its Spirit in Sand, as this we have now mentioned: Is also White, and more unctuous; hath a grain more like Nitre than Vitriol; as hath also the *Goslar* Vitriol, which is White, and comparatively unctuous, because it hath little Metal, and less Mineral-Sulphur than the Common; whose Metalline part detains the Saline, and will not dismiss it until long urged by a very intense degree of heat. What remained in the Retort, after this distillation, was not red or purple, like the *Caput mortuum* of Common Vitriol, but white, light, and spongious, like burnt Allom, and altogether as insipid; although, after it was some time exposed unto the Air, it received many strange impressions and alterations; which, though very remarkable, I omit, as not answering my present design, which is to enquire, whence the Saline principle in Vitriol proceeds, and how it comes to be so compounded? But first, I cannot but take notice of the great affinity that is between *Vitriol*, *Allom*, and *Mineral Sulphur*; the Saline Principle, which is in each of them by far the chief, both in quantity and energy, having one nature and the same properties; although in the last clog'd with a small portion of Sulphur. For notwithstanding what is commonly received, I shall clearly prove, that the body of Common Sulphur is a Vitriol Salt, the very same with that, which is separable from Common Vitriol; and that the Sulphureous parts are not only less copious, but inconsiderable for bulk, compared with the Saline; which are sincere Vitriol, not differing from the Common; only that doth not so much abound in Metallick and Earthy particles.

So far the Author for this time, having been unexpectedly interrupted to proceed in this design, which he hath promised to finish for the next opportunity.

Some

The following Addreſs having been read to this Royal Society, the Preſident and Council of the ſame, being deſirous to encourage, as much as may be, an Undertaking ſo uſeful, deſire the ſeveral Members thereof, and their learned and ingenious Correſpondents, to communicate their Obſervations, directed to their Secretaries, in Crane-Court, Fleet-Street.

CVII. *An Attempt to point out, in a conciſe manner, the Advantages which will accrue from a periodic Review of the Variation of the magnetic Needle, throughout the known World; addreſſed to this Royal Society by* William Mountaine *and* James Dodſon, *Fellows of the ſaid Society, and requeſting their Contribution thereto, by communicating ſuch Obſervations concerning it, as they have lately made, or can procure from their Correſpondents in foreign Parts.*

London, March 20, 1755.

Read March 20, 1755.

ABOUT the year 1700, the juſtly celebrated Doctor Edmund Halley having collected together a great number of obſervations, made on the variation of the needle, in many parts of the world, drew (on a mercator CHART) certain lines, ſhewing the quantity of that variation, in thoſe parts of the world, over the repreſentation of which thoſe lines were drawn; but as the quantity

of this variation is in a perpetual ſtate of fluctuation, in (perhaps) every part of the world, it had been ſo much changed in the ſpace of forty years, or thereabouts, that (when the writers of this paper endeavoured about the year 1744, to draw thereon, other lines to anſwer the purpoſes above-mentioned) they found that thoſe laid down by Doctor Halley were grown intirely uſeleſs; and that a ſyſtem of ſuch lines, or ſomething analogous thereto, ſhould be performed once in every ten or twelve years at leaſt, in order to anſwer the purpoſes intended, by that ſagacious gentleman.

In the reconſtruction of them, the writers received the aſſiſtance of the commiſſioners of the navy, and of the directors of the Eaſt-India and African companies, having leave to peruſe the journals of thoſe mariners, which were under the direction of each reſpective body; From theſe, and a few private communications, they were enabled to draw the proper lines over the moſt frequented ſeas, and to make ſome attempts toward doing the ſame in thoſe leaſt ſo; A copy of the CHART, thus again rendered uſeful, they preſented to this Royal Society, with an account of the methods uſed in performing the ſame.

Although the moſt beneficial uſe of theſe lines belongs to the ſea, yet if they could be extended over the land likewiſe, the advantages ariſing would more than compenſate the trouble, as will appear by taking a ſhort view of each.

And firſt, the uſe of theſe lines at ſea may be conſidered either as common to the art of navigating in all large bodies of water; or as particular in ſome ſuch: the general uſe being that of ſteering the true courſe

courſe deſigned, and finding the ſhip's true place, as near as may be, by what the mariners call the dead-reckoning.

The particular uſes will be beſt explained by examples; for inſtance, in the ſouthern parts of the great Atlantic ocean, beginning with the coaſt of Brazil and Patagonia, and proceeding to the ſouth of the Cape of Good Hope into the Indian ocean, as far as the common tracks of our Eaſt-India ſhips extend, the variation lines have appeared to be, for the moſt part, directed northward and ſouthward; whence, in moſt places of that great body of waters, if the latitude and variation be found by celeſtial obſervations, the longitude will be obtained by the lines on the chart; the great uſefulneſs of which has been atteſted to the writers, by many perſons who have, ſucceſsfully to themſelves, practically applied the laſt conſtructed CHART, to correct their dead-reckoning on that long paſſage.

Indeed, where the variation lines run nearly eaſtward and weſtward, as has appeared in the Atlantic ocean, from the weſt coaſt of Europe to the eaſt coaſt of North America, no aſſiſtance toward obtaining the longitude can be derived from them; but as it frequently happens, within thoſe limits, that meridian obſervations, for determining the latitude, cannot be obtained, eſpecially about Newfoundland; then, if a good obſervation of the variation can be taken, at any time of the day, the latitude may be nearly aſcertained by the lines on the CHART.

Secondly, The advantage that will ariſe by extending the variation lines over the land, as well as ſea, will be the confirmation of thoſe drawn over the

waters;

waters; the continuation of which, from ſea to ſea, will be thereby conſpicuous, and we ſhall be enabled to judge better of their nature, properties and cauſes; and, if the ſame can be extended over all the parts of the known world, the eye will be preſented, at one view, with the different degrees of attraction, with which all the parts of this great magnet are endued, at the time when ſuch lines are drawn; This the writers would have attempted to have done, in the year 1744, if they could have procured a ſufficient number of obſervations for that purpoſe; but although they frequently advertiſed their requeſt, in the public papers, no aſſiſtance was thereby obtained.

As the writers have by experience found, that the proper period for re-examining the ſtate of the variation is now at hand, without which the above-mentioned valuable advantages of the CHART will be loſt to the mariner; they have determined to collect and compare all the obſervations that can be procured by them, in the ſpace of a year from this time, or ſo long after as the return of the Eaſt-India ſhips then next following; if ſuch delay ſhould become neceſſary, by the ariſing of any doubt in conſequence of ſuch compariſon; and then to publiſh the reſult of their proceſs, in ſuch a manner as ſhall ſeem moſt convenient.

Several of the learned and ingenious have endeavoured to account for this phænomenon of the variation of the magnetic-needle, and the continual mutation thereof; whence different methods of computation have been propoſed, whereby they have endeavoured to determine what the quantity of the

variation will (according to their ſeveral hypotheſes) be at any given place and time: The above propoſition, therefore, will (if carried into execution) bring theſe ſeverally to the teſt, and enable the judicious either to approve or reject them; the writers being determined (as was their former plan) to publiſh nothing which ſhall not be warranted by the real obſervations, which ſhall come into their hands, and ſhall leave the application thereof (as to each hypotheſis) to others: if any of them ſhould be ſo far confirmed, by this examination and compariſon, as to give juſt ground for a calculation, their labour will be at an end; but if not, they humbly recommend the continuance of ſuch a periodic operation, as they now propoſe to undertake, being the only means of attaining ſuch a deſirable event, and of ſupplying the defect till it can be obtained.

To whom then can they ſo properly apply, as to the Royal Society of London, for aſſiſtance, in a work of ſo much conſequence to trade and navigation, and from whence ſo valuable an addition to natural knowledge may poſſibly accrue: It has been the peculiar honour of the many illuſtrious members of this body, that they have deduced their knowlege from experiments, and not from hypotheſes; and (as that is the method now propoſed) the writers of this paper humbly deſire of this Society, as a body, and of each individual that compoſes it, to communicate to them ſuch obſervations of the variation as they have already made within a few years laſt paſt, or ſhall hereafter make, before the 25th of March 1756, either by ſea or land; and (as all mankind

are

are equally interested in this research) that they will endeavour to procure the like favour from their several correspondents in foreign countries: They beg leave to assure the Society, and its particular members, that they shall receive a grateful acknowlegement of this favour, granted; and an early information of any thing relating hereto, which the writers shall conceive to be worthy their attention.

The END of VOL. XLVIII.

Additions