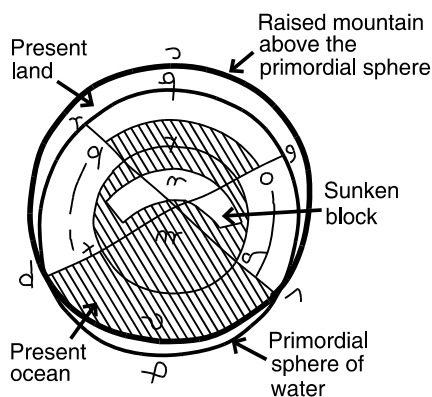


a31 Why we could forget Leonardo, as a geologist, but not Werner < Steno >

“Don’t confuse facts,” a Wernerian might bluster, “with the truth!”¹

Leonardo da Vinci (1452-1519), could have founded modern geology at the time of the Renaissance. His personal writings (more than his telling drawings) reveal that he thought as a uniformitarianist but during his lifetime, other than for practical, mostly war related, inventions, he did not dare to reveal to others all his insights into the *natural* world. After his death, five thousand pages of his manuscript notes became indiscriminately dispersed to collectors as widely as the miscellany of their content. So of his gained knowledge, the little interest as he had shown to inform others was perpetuated and came to serve only curiosity when, beginning towards the end of the 1800s, scholars took time-out to reverse his notes’ cryptology of shorthand and spelling, and words combined and divided according to a system of his own, and text flowing backwards (written with his left hand) with reversed characters.



“The great elevations of the peaks of the mountains above the sphere of the water may have resulted from this that: a very portion of the earth which was filled with water that is to say the vast cavern inside the earth may have fallen in a vast part of its vault towards the centre of the earth, being pierced by means of the course of the springs which continually wear away the place where they pass.”²

Paraphrasing some of his geological opinions (given in *The Notebooks of Leonardo Da Vinci*, Vol II, 1970, translated by Jean Paul Richter): “The element water, wherever exposed, has at every elevation a spherical surface with its center coincident with the center of the universe. Sun’s heat draws water to higher elevation: up into the atmosphere as vapor to be blown by the wind, to condense, and to fall as rain; and water, which by wicking leaves salt behind, moves up through Earth’s interior to flow out as springs. The element Earth has an irregular shape and is with cavities. It is immersed in the element water except for those parts, which higher than the spherical surface of the ocean, project as land. Importantly, Earth’s shape is ever undergoing change because its material is moved: by water flowing at its surface to lower elevations, by water moving up through Earth’s interior, by collapse of dissolved-out cavities. Sediments that accumulate as strata with marine shells in the ocean can be raised into mountains for while the shape of the element Earth is continually changed by the several causes given, its center remains fixed at the center of the universe.”—HR

These of Leonardo’s opinions, some nonsensical today as is the idea, possibly stemming from of a valid study of soil profiles, that fresh spring water has left salt behind as it is drawn by Sun’s heat to the surface from deep within Earth’s interior (which we know is operatively false), and elsewhere the notion that a boulder transport by a river becomes ground down to a grain of sand (while we know, grains of sand start as grains of sand where released by weathering, and stay unchanged in their sand-size during transportation while becoming rounded), may have become known to Nicolaus Steno via Manfredo Settala. The case for such is made by François Ellenberger in his *Histoire de la Géologie*, 1988. Steno’s understanding that inclined strata were not originally so may thus have been derived. Leonardo’s model was one of gradualism, whereas Steno’s model was one of catastrophic collapses. But any need for deep time did not impress itself upon Steno: Metallic ores veins that must be arduously mined and jewels, unnecessary for life, he would instruct are blemishes wrought at mankind’s expulsion from Eden and serve to remind of original sin.³ His theme that Earth’s history is recorded by the accumulation of strata interrupted by catastrophic events (sudden changes of sea level, floods, mountain building) was transmitted to Werner by the published works of Johann Gottlieb Lehmann (1719-1761) and Georg Christian Fuchsel (1722-1773).⁴

Three hundred years separated Hutton (1726-1797) from Leonardo when in 1788, unaware of Leonardo's priority, he proposed the philosophy of (what came to be called) *uniformitarianism* as an induction aiding tool for understanding the natural world. Hutton, in an age and place (somewhat) more tolerant of free thought (that respects neither national nor confessional boundaries) could make his insight available to all and so founded geology. But, without what could have been already a renaissance in natural science, Werner (1749-1817) was free to promote in 1787 his geognosy. Even in Edinburgh where Hutton expounded on his views to the Philosophical Society, his uniformitarian ideas were unacceptable at the University. Intellectuals in England would champion Hutton's philosophy but Wernerian thinking, being less at odds with religious doctrine, would continue to confound the development of modern geology well into the last century (**Table a31.1**).

JSB (John Seely Brown) differentiates explicit and tacit knowledge:

Explicit knowledge is most easily shared with words, books and seminars. More than theory, it's what is identifiable about a process. An example is riding a bicycle. You can explain many of the fundamentals such as pedaling, braking, turning and so on.

Even so, as with many tasks, there are important elements that are difficult to transfer because they're difficult to identify. You just know. That's tacit knowledge.

Tacit knowledge is what people learn by doing. What they don't even know they've learned. It's the knack. In the bicycling example, it turns out that very few people can tell you which way to turn the handlebars if you're falling—into the turn or away from it. Of course, anyone who can ride a bike must know this. But it's surprising how many people don't know they know it.⁵

Tacit knowledge (also known as “expert” knowledge) when valid of the real world can be turned into explicit knowledge by science. Whatever such tacit knowledge was in Wernerian geognosy has been made explicit in geology and the rest should be laid to rest. Paraleipsis⁶ is the avowal to write no more of Werner's formations: Alluvial (and Volcanic), Stratified, Transition, and Primitive. □

Table a31.1 Contesting geological traditions Data from *Timing of Orogenic Events* by A. M. C. Şengör in *Controversies in Modern Geology*, 1991.⁷

WEGENER-ARGANDIANS

ascribe to Hutton's uniformitarian philosophy.

KOBER-STILLEANS

until recently more numerous than Wegener-Argandians, carry forward the Wernerian concept of universal formations separated by worldwide unconformities.

I. PRE-BIOSTRATIGRAPHY

Hutton

No worldwide layer-cake stratigraphy.

Werner

Worldwide layer-cake stratigraphy.

II. WITH BIOSTRATIGRAPHY

Lyell

Worldwide episodes of convulsion alternating with those of rest result from confusing time with rock.

Cuvier and Élie de Beaumont

Worldwide layer-cake stratigraphy is a consequence of the existence of worldwide episodes of convulsion alternating with those of rest.

Suess

Orogenic belts grow slowly and semi-continuously. Orogenic episodes are neither worldwide nor synchronous. Worldwide stratigraphic correlation is possible because of “eustatic” (*see* Footnote b28.1, p. 113) events.

Dana and Chamberlin

Orogenic belts grow during “critical times” in Earth history, which alternate with times of tranquillity.

Wegener and Argand

Orogeny is continuous, but its record is not. Unconformity means termination of deposition but not of movement.

Kober and Stille

Orogeny is confined in time to worldwide synchronous phases of short duration (+300,000 a). Only 1/40 of the Phanerozoic was “orogenic.”