

## *i2* Explanations of ocean basins < sial, sima >

These ‘savants’ – as the investigators who studied nature were known in those days – had a modern face looking towards us, and an older face glancing back towards the past. In their own minds, of course, they were not two-faced; it was their world which was two-faced, with its burdensome past obstructing progress and a Utopian future waiting to be born.

—Ken Alder *The Measure of all Things*.<sup>2</sup>

A model for early Earth, long entertained, was that of a universal sea or “panthalassa” (Suess’ term) enveloping a shell of silica-rich (granitic) rocks (that Suess called “sal” from silicon and aluminum and which, following a suggestion by Georg Johann Pfeffer (1854-1931), Wegener called “sial” to avoid confusion with the Latin word for salt),<sup>3</sup> upon a denser subcrust of “sima” (Suess’ term for basaltic rocks rich in silicon and magnesium). Earth cools by radiation of its primordial heat into space (true). Earth’s interior contracts as a consequence and the shrinkage results in bucklings of the sial shell (false as rock-creep can easily relieve stress due to Earth cooling). To wit: oceans occupy down-buckles (false) and continents are emergent up-buckles (false).

In 1876, George Howard Darwin (1845-1912) (the second son of Charles Darwin) calculated that when Earth spun with a 5 1/2 hour day 67 million years ago (false), Moon was ejected to expose sima in the scar of separation (the Pacific ocean basin). And indeed, Moon’s low density indicates that it could be a torn-out piece of Earth’s mantle. G. Darwin thought that the Pacific sima will in time become closed over by sial as a result of Earth’s ongoing cooling contraction. Osmond Fisher (1817-1914) saw additional explanatory consequences to G. Darwin’s “fissipartition” scenario. All the deep oceans, he proposed, could have been created at the same time that the Pacific was. Tensional forces that lifted at the Pacific, elsewhere had pulled laterally to tear Earth’s sial shell into continental fragments. The Pacificward movement of these sial fragments, which are the present continents, opened the Atlantic and Indian oceans and exposed sima where they no longer cover.<sup>4</sup>

In 1908, Frank Bursley Taylor (1860-1938) envisaged Earth capture of the Moon at the beginning of the Cretaceous (false). The accompanying tidal event tore open the Atlantic. The evidence he offered is that Cretaceous sediments on either side of the Atlantic are not deformed into mountains but pre-Cretaceous sediments have been dragged into fold mountains about the Pacific and also between Eurasia and Africa-India.<sup>5</sup> In 1932, after twenty three years of cogitation, Howard B. Baker (1872-?) had Moon torn tidally out of Earth by Venus that had orbited chaotically close by.<sup>6</sup> Immanuel Velikovsky (1895-1979), anachronistically, was loath to let such a sensational idea die.<sup>7</sup>

The above are catastrophist hypotheses for the origin of the ocean basins. At the time, the fixity of the continents principle made them maverick. The first to make a uniformitarian case that the continents are in no sense fixed in their geographic locations was Alfred Lothar Wegener (1880-1930) starting in 1912 (*see* Topic *i3*).

Wegener’s early success, as a doctoral student of astronomy, was to explain, in uniformitarian terms, why Earth’s surface elevations have a bimodal distribution (**Figure i2.1**). Wegener deduced, from gravity measurements, that the continents stand consistently higher than the ocean floors because the continental sial (“granitic rock with a specific gravity of 2.70”) is buoyant in the denser oceanic sima (“basaltic rock with a specific gravity of 2.95”) (true). In this isostatic model with crust to subcrust specific gravities ratio of 0.915 (which is nearly ice to pure water specific gravities ratio of 0.9168 at 0°C), the continents are likened to icebergs floating in fresh water. (Ice to seawater specific gravities are in the approximate ratio of 0.915/1.026 = 0.892).<sup>8</sup> Icebergs (read sial continents) are emergent in the proportion that Archimedes’ principle allows for the volume of water (read sima subcrust and seafloor rock) they displace.<sup>9</sup> However, there is nothing very new here. In *Physics of the Earth’s Crust*, 1881, O. Fisher had adopted the same Airy isostatic model and had used a crust to subcrust specific gravities ratio of 0.905.<sup>10</sup> 