i14 Tillite compositions are evidence of continental drift

< dearth of sima clasts, Lester Charles King >

> It occurs. —L. C. King's droll response elicited by the recounting of an observation that had surprised the teller.[1]

Before the 1950s, gravity studies had indicated that the ocean basins could be areas of sima but geologists were not convinced. Du Toit had assumed that the Tethys, although a deep, and persistent, ocean, was underlain by sial. This accorded to Arthur Holmes' earlier likening of it to the existing Baltic in Europe, or Hudson Bay in Canada, which are seas underlain by sial that "have always been more or less flooded by oceanic waters."[2]

During the 1950s, a revolution in the understanding of the nature of the deep-ocean floor resulted from seismic refraction studies. In 1956, R. W. Raitt was able to state that the Moho occurs at "an almost uniform depth of 6.5 km" beneath the deep-ocean floors.[3] The Moho in oceanic areas is the boundary between rocks that transmit sound above it at velocities of 6.4 to 6.8 km/sec and below it at 8 km/sec. These velocities are too rapid for the transmitting-materials to be sediments or sial. A model for the ocean basins (top down) is: deep seawater, a relatively thin layer of seafloor sediments, and underlying sima within which the Moho occurs. Velocities in the oceanic sima-rock are indicative of basalt or serpentinized peridotite above the Moho and of peridotite below. Dredge samples from the fault scarps of the Mid-Atlantic Ridge, described by S. J. Shand in 1949, were of serpentinized peridotite.[4] This information, even as late as 1960, fed into H. H. Hess' hypothesis that the remarkably uniform depth of the Moho in oceanic areas indicated that it was "the position of an isotherm or past isotherm" (a thermal boundary).[5] That turned out to be wrong. The Moho is a compositional boundary. However, of crucial importance to the continental-drift hypotheses was the unshakable fact that the bedrock of the deepsea floor *is* almost everywhere sima. That information, and first-hand knowledge of the composition of the Late Paleozoic Dwyka tillite in South Africa, gave Lester Charles King (1907-1989), an advocate for continental drift, decisive geological proof.

Conspicuous by their absence in the Dwyka tillite are clasts of sima. Present are glacially abraded granite pebbles and quartz grains.[6] Du Toit had noted the direction of the movement of Late Paleozoic gondwanide ice sheet that had deposited the tillite. He had found in several places that the direction had been from where there is deep ocean today (notably, the flow of glacial ice toward the Natal coast of South Africa from the direction of the Indian Ocean (***Figure i14.1***) and, even more dramatically, toward southern Brazil from the direction of the Atlantic Ocean). Today, glaciers nowhere flow from the ocean onto the land. On mechanical and uniformitarian grounds, nor did they in the past. (However, Eskimo have a word *ivu* for huge pieces of sea ice that midwinter, without warning, occasionally surge hundreds of feet inland.)[7] Presumably, where deep ocean is now, land was. The composition of the tillite indicated to du Toit that this vanished land had been sial and so for him the tillite compositions had no value as a test of the continental-drift hypothesis. Du Toit even had this to say: "Through following Wegener too closely, the general picture has usually been one of oceans floored by bare sima, whereas the evidence points strongly to quite a thickness of material of at least intermediate composition, if not of acid character, intervening between the oceanic waters and the sima below."[8]

But King's information was that the deep-oceanic areas *are* floored by sima. Tills contain representative samples of any hard rock over which the ice that deposits them has passed. For example, in Pleistocene tills of the Long Island terminal moraine, New York, can be found clasts of Peekskill granite (sial) as well as samples of Palisades diabase and Cortland Complex ultrabasics (both sima). The lack of abundant sima clasts in Dwyka tillites is clear proof that the ground over which the gondwanide ice sheet had flowed could not have been raised deep-ocean floor.

On tour in America in the late 1950s, King gave popular lectures that disseminated this information and likely lessened the scepticism of many as to the reality of drift.[9]

Figure ***i****14.1*[8] **Map showing the inferred radiations of Dwyka ice.**

The arrows show observed directions of glacial striations (dashed lines are extrapolations) and movement along these as indicated by chatter marks and roches moutonnées.

From 'D,' ice apparently flowed from where the Indian Ocean is today onto the land.

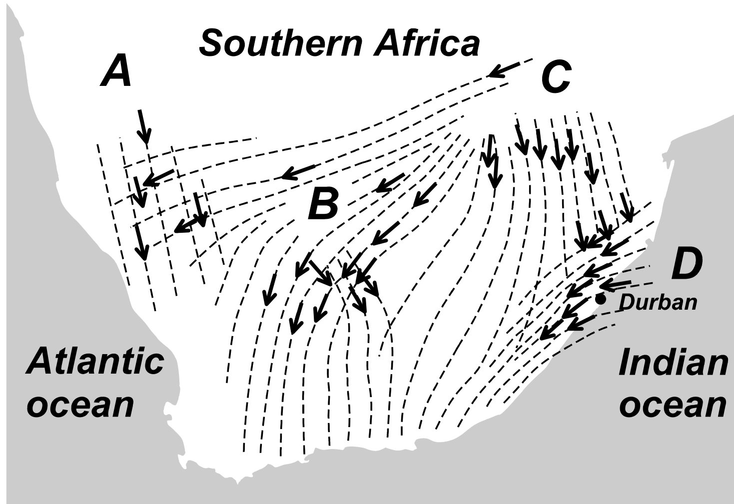
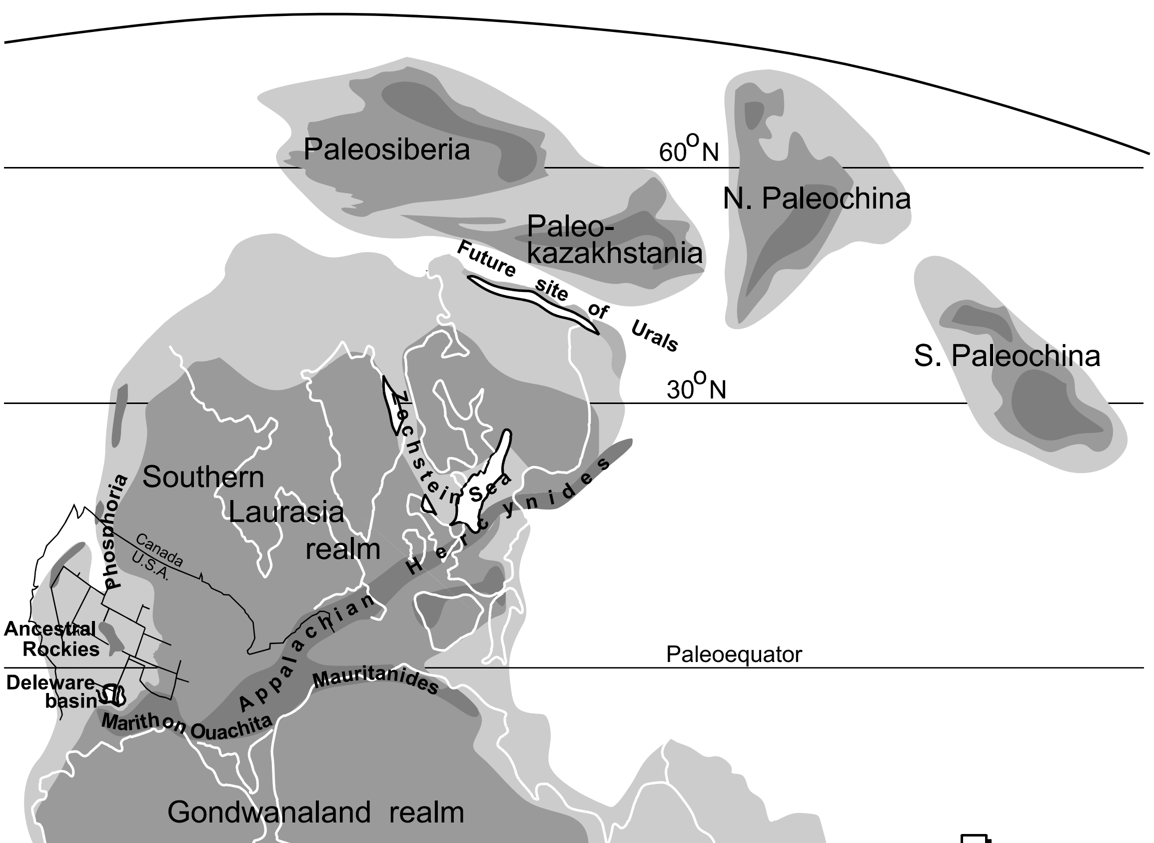


Figure ***i****15.1* **Late Permian paleogeography**. Land (gray) and mountains (dark gray), epeiric seas (pale gray) and evaporite basins (white with black outline)

By the Late Permian, Pangea-to-be was comprised of the Southern Laurasia and Gondwanaland realms. Between these realms were intracontinent mountains with thin-skinned thrust fault and fold displacements outward-directed along the line of joining of the prior paleocontinents; ORS (Old Red Sandstone) and Gondwana, respectively. Their suturing orogenies, traced east, are called: *Marathon*, *Ouachita*, *Alleghenian* (or *Appalachian*), and *Hercynian*. The Hercynian mobile belt branches east into the northerly Hercynides, the southerly Mauritanides, and the pre-Alpine between.



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