THE SOURCE OF LUNAR BASALTS IN THE NORTHERN OCEANUS PROCELLARUM REGION.

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ABSTRACT.

Analysis of Clementine remote sensing data permits new observations and therefore results to be obtained about mineral distribution on the lunar surface, basalt flow stratigraphy and thus the geological evolution of the Moon. In particular the northern section of Oceanus Procellarum contains numerous impact craters that have penetrated the basalt to different depths, providing natural probes for estimating the number and thickness of flows. These estimates, when coupled with a relative height topographic map, can be used to infer the source direction of the basalts flows.

Clementine derived images, that include the primary mosaic image (415, 750, and 950 nm bands), ratio image (750/415, 750/950, and 415/750) (3) (Fig 1), and the iron image (7) all indicate that basalt flows in the northern Oceanus Procellarum region change in composition over time and that different layers can be correlated over large areas based on their composition. The western parts of the northern portion of the mare are bounded by anorthositic highlands covered by anorthositic regolith and contains widespread titanium-poor basalts. In contrast, in the eastern Oceanus Procellarum, the larger craters expose at least two basalt flows greater than one kilometre thick; each titanium-rich surface unit, underlain by titanium-poor unit that itself is underlain by anorthositic basement. A statistical sample of craters to 20 kilometers in diameter was used to derive the relative thickness of the basalt layer(s). Using the relationship that depth equals ten percent of the diameter for craters up to about 20 kilometres (2, and 4). In addition, hand drawn isopach diagram (Figs 2 and 3) and computer generated graphics (Fig 4) for the basalt layers provide area and volume estimates that are in reasonable agreement. The titanium-rich basalts are estimated, in the region to be as young as 1.1 billion years old (5), (8), while the titanium-poor basalts (Apollo 12 basalt samples), are estimated in age between 3.08 and 3.37 billion years (5). In the northern Oceanus Procellarum (area 525,000 square kilometres), the volume of basalt exceeds 240,000 cubic kilometres. The titanium rich surface layer is estimated to be 48,000 cu km and the titanium poor second basalt layer is about 193,000 cu kilometers (6). The resulting isopach cross sections combined with topographic maps (1,and 9) infer that the titanium poor basalts flowed from a northwesterly direction while the titanium rich basalts flowed from a northeasterly direction into Oceanus Procellarum.

These results in turn- provide a new set of constraints that need to be explained by models of the geothermal history of the Moon

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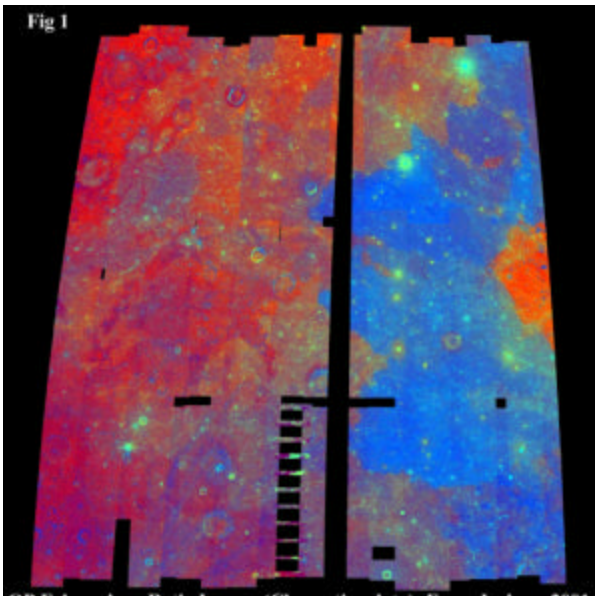
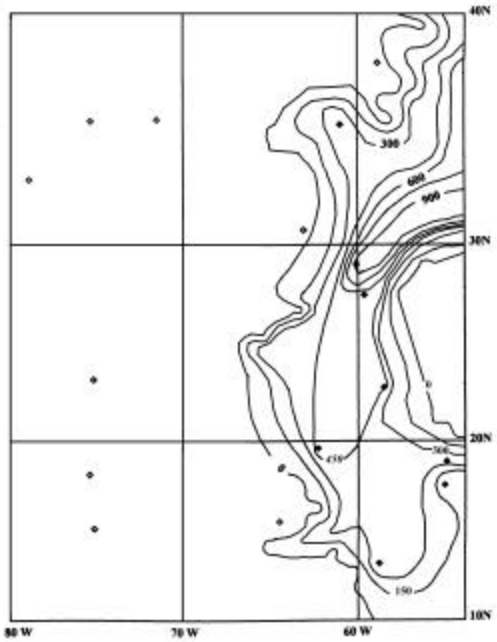
Lunar iron and titanium abundance algorithmsbased on final processing of Clementine UVVIS data, Journal of Geophysical. Research, 2000. (8) Spudis P.D., *Once and future Moon*, Smithsonian Institution, 1996. (9) US Geological Survey, Weir D. ed)*"Atlas of the Moon"; 1:5,000,000 Topographic Series, The Lunar Near Side, L 5M 0/0 R, 1992, MAP I-2276 (Sheet 1 of 2,* 1990). Projection is Conical Mercator. . Map of study area in northern Oceanus Procellarum

Fig 1



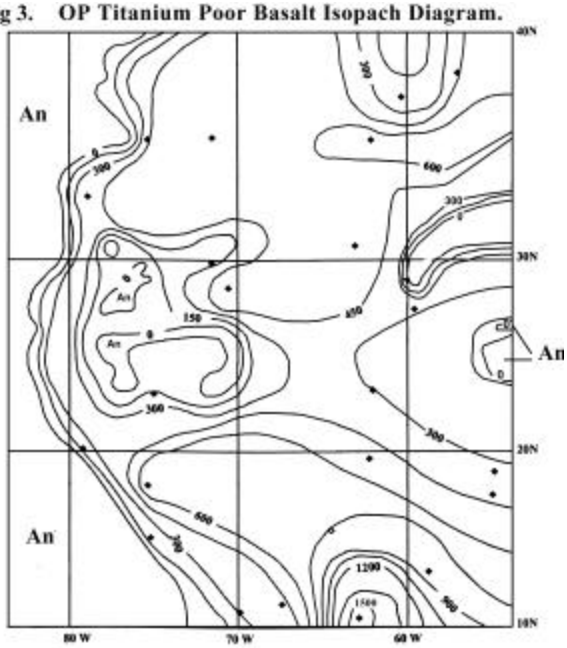
OP False colour Ratio Images (Clementine data)- From Jackson 2001

Fig.2. OP Titanium Rich Basalt Isopach Diagram



Isopach interval = 150 metres

Fig 3. OP Titanium Poor Basalt Isopach Diagram.



An = Anorthosite (Highland areas and Outcrop)