The Formation of Rima Parry V. P. A. Jackson and L. Wilson, Environmental Science Division, Institute of Environmental and Biological Sciences, Lancaster University, Lancaster LA1 4YQ, U.K.

Abstract: Head & Wilson [1] identified Rima Parry V, a graben in the Fra Mauro formation [2], as having formed as a result of shallow dyke intrusion. The presence of surface volcanics indicates a magma source at shallow depth, and the geometry of the graben faults in Rima Parry V indicates the presence of a shallow dyke beneath them. Head & Wilson [1] determined the depth to the dyke top to be ~650 m and the width of the dyke to be ~150 m, which is consistent with predictions for dykes propagating from the base of the crust. The minimum source depth was inferred to be 50 km, not too different from the thickness of the nearside lunar crust (~65 km). We have re-mapped the area in great detail using Lunar Orbiter and Clementine data, and using crater counts to determine the relative ages of geological units present. We find that the underlying dyke probably has a greater horizontal extent than previously thought.

The area around Rima Parry V was mapped using Lunar Orbiter frames V38M, V39M and V40M. Clementine data at all three available wavelengths (415 nm, 750 nm, 950 nm) were used to map the same area. Features in the Clementine images were related to those in the Orbiter images and the analysis was then extended northwards using the Clementine data alone. Using the corresponding high-resolution Orbiter frames, as many units as possible were crater-counted to determine their ages. The Clementine data were also used to classify areas with similar spectral properties, and thus extend the geological interpretation, by ratioing corresponding frames at different wavelengths. The resulting geological map of the Rima Parry V area (see Fig.) leads to the following interpretations.

Rima Parry I was found to predate Rima Parry V, although it was found to be younger than the surrounding surface. The Rima Parry V structure and the patch of lava midway along it (B) were found to be of similar age. Three areas of volcanic deposits were identified along Rima Parry V: an extensive patch of lava on the floor of the crater Bonpland and a volcanic cone alongside Rima Parry V in Bonpland (A); the cones and lava midway along Rima Parry V (B) previously identified by Schultz [2] and Head & Wilson [1]; and a lava deposit at the intersection of Rimae Parry I and V (C). A similar volcanic deposit was found to the north of Rima Parry V (D). Rima Parry V cuts through the deposit in Bonpland, suggesting that this deposit predates the rille.

Using methods described in [1], the geometries of the faults bounding Rima Parry V were used to find the depth to the top of the dyke beneath the rille as a function of lateral position. A vertical cross-section of the dyke profile was thus produced. The analysis is based on a two-dimensional treatment given by Mastin & Pollard [3] which assumes that the dyke top is horizontal along strike. In practice, the top of a dyke will be curved, and closest to the surface near the middle of the dyke;, the results of the analysis given in Table 1 can only be considered as approximate, therefore.

The volcanic cone in Bonpland (A) appears to be associated with Rima Parry V, as the vertical profile shows the dyke to be near to the surface here due to the lower elevation of the floor of Bonpland relative to Fra Mauro. An anomolously small graben depth was also found near this cone, perhaps suggesting the presence of ash, as documented by Schultz [2] for the volcanic area in the middle of Rima Parry V (B).

The deposits (B) midway along Rima Parry V consist of a number of cones and a surrounding area of lava. Intermittent Strombolian eruptions best account for these deposits [1], and the presence of shallow craters and some anomolously shallow graben depths would suggest the presence of ash, thus supporting this proposed eruption mechanism.

The deposit at the intersection of Rimae Parry V and I (C) is located at the shallowest part of the dyke top as indicated by the vertical profile (Table 1).Magma probably propagated up the pre-existing fault planes of Rima Parry I to the surface. There are no volcanic deposits between 30 and 50 km along Rima Parry V from its start in Bonpland due to the local crustal stresses exerted by Rima Parry I.

The spectroscopic (image ratioing) analysis showed that areas mapped as lavas from the Orbiter images were indeed of different composition from the surrounding surface, and furthermore three distinct geological units were identified: younger lavas associated with Rima Parry V; Imbrian age deposits filling the floors of the Bonpland and Fra Mauro craters; and the rocks of the original Fra Mauro formation.

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Analysis of the Clementine images showed the presence of a linear feature to the north of Rima Parry V that is approximately 20 km long. This is similar in appearance to Rima Parry V and to Rima Parry I, suggesting a similar origin. The fact that Rimae Parry I and V, and the linear feature to the north, were visible in the ratio images suggests an altered composition for the surrounding surface, and this is probably due to degassing from the dyke and/or an ash covering. There is also a volcanic deposit (D), similar in appearance to the other deposits associated with the dyke, at the end of the linear feature, approximately 100 km from the start of Rima Parry V in Bonpland. Thus the altered composition of the linear feature, and the presence of a volcanic deposit at the northern end of it, would seem to suggest that the dyke extends under this feature as well, meaning that the dyke's near-surface lateral extent approaches 100 km, twice that estimated by Head & Wilson [1], and that the centre of the dyke occurs around the intersection of Rimae Parry V and I, as suggested earlier from the vertical profile. Lateral magma migration along the boundary faults of Rima Parry I caused surface alteration due to either chemical reaction with gas or the eruption of some ash. Vertical degassing of the dyke below Rima Parry V and the linear feature to the north of Rima Parry V had the same effect.

The linear feature could have formed before or after the dyke intruded. If before, then it is likely that the dyke propagated horizontally along the fault planes, and if after, then the rille could have formed in the same way as Rima Parry V.

Summary: Our analysis supports the earlier suggestion [1] that Rima Parry V formed over a shallow intrusion, and suggests that the underlying dyke extends further to the north than previously documented.

References: [1] Head, J.W. & Wilson, L. (1993) Plan. Space Sci. 41, 719. [2] Schultz, P. (1972) Moon Morphology. [3] Mastin, L.G.. & Pollard, D.D. (1988) JGR 93, 13221.

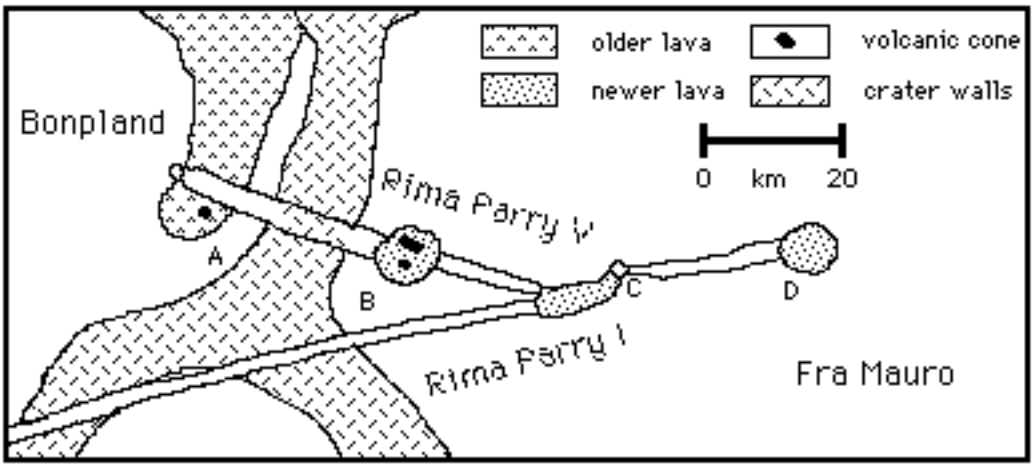

Table: Data on surface topography and inferred depth of dyke top relative to a datum at the south end of the rille. The symbol ? indicates that no realiable value could be determined.

Distance from south end of rille in km	0.0	6.9	10.2	12.7	16.4	20.0	32.9	37.1	46.5
surface elevation in metres above datum	0	70	70	695	1650	700	500	500	500
depth of dyke top in metres below datum	275	460	640	180	?	?	-10	-70	-150