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Structure of Submarine Large Lobate Sheet Flow from the Oman Ophiolite: a Submarine Analogue of Flood Basalt Lavas

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INTRODUCTION

Coalescence and inflation of flow lobes are common to fluidal basaltic lava emplaced on a subhorizontal field, which are fundamental mechanisms to form vast sheet-like lava flows. Flow-lobe coalescence and inflation are also known from submarine flows from mid-ocean ridges and submarine extensions of Hawaiian rift zones. The V3 extrusive unit (Salahi Volcanics) of the Oman Ophiolite is an extensive sheet flow of alkali basalt attaining 12 km in length and as thick as 100 m, with an estimated volume >2 km^3. I propose that this unusually thick sheet flow was formed by complex flow-lobe coalescence and inflation of subaqueous lava lobes extruded at low supply rates of lava.

DISTRIBUTION OF V3 EXTRUSIVE UNIT

V3 extrusive unit (Salahi Volcanics) and an alkali basalt feeder dike is the last volcanic products of the Oman Ophiolite in the northern Oman Mountains [Alabaster and Pearce, 1982; Bishimetal Exploration Co. Ltd., 1987; Umino et al., 1990, 2003]. V3 distribution is elongated NNW-SSE subparallel to the paleo-ridge axis with the base showing zigzag outlines bourdered by ridge-parallel faults. Such a distribution indicates that V3 flows filled fault grabens with bases stepping down toward east, suggesting that the paleoridge axis was located to the west.

STRUCTURE OF V3 EXTRUSIVE UNIT

V3 mainly consists of 3 sheet flows separated by red shale beds associated with pillow and pahoehoe flows. An alkali dolerite dike >30 m in thickness to the southern end of V3 distribution is assumed to be the source of V3 lavas, intruding into the Alley Volcanics (V2) beneath V3. Ropy wrinkles are commonly observed on the top and bottom of the sheets, indicating north to north-westerly flow directions.

Sheet flows occasionally grade into pillows and pahoehoe lobes both laterally and downward, which directly grow from the base or peripherals of sheet flows. Red shale fills interstices between pillows and fractures along the cooling joints in the base of sheet flows. Because pillows are formed on slopes >5 degrees, the above occurrence indicates that the slowly advancing lava formed pillows as it flowed down into a depression filled with unconsolidated mud. As the depression was buried by pillow lavas, lava advanced onto the subhorizontal top of pillows, forming pahoehoe lobes which were coalesced and inflated to a thick sheet-like lava.

The lowest sheet flow (SF-1) has the largest extension and thickness among the three sheets. It has columnar jointed upper and lower crusts, and massive cores, among which the upper crust is thickest. Such joint structures also develop in subaerial flood basalts, but are more complex in the Salahi SF-1. Most part of SF-1 has only one core between the upper and lower crusts, while in places core is separated by a columnar jointed layer, or no core appears in other places. The core lacks dendritic clinopyroxene, showing a typical doleritic texture. In contrast, the crust contains thin and elongated clinopyroxene, suggestive of crystallization under a large degree of supercooling.The roof of the sheet develops domed structures several metres to a few hundred

metres across. Finely jointed zones beneath such domed roofs sometimes continue into and thin out within the crust below the neighbouring roof. Such finely jointed layers and lenses are most plausibly seal zones of coalesced flow lobes.
Hyaloclastite veins are found along vertical joints in the lower part of the upper crust. Repeated fragmentation of chilled margins along the joints indicates that molten lava was in contact with water entered through deep inflation cracks into the upper crust, which opened as the lobes inflated.

CONCLUSIONS

The above mentioned observations led us to conclude that the crusts were formed by coalescence of partially overlapped or stacked flow lobes, while the core developed endogenously as the sheet inflated. Meanwhile inflation cracks opened and penetrated deep into the crust.

Keywords: Oman Ophiolite, Lobate sheet flow, Inflation structure, Flood basalt,
Large Igneous Province