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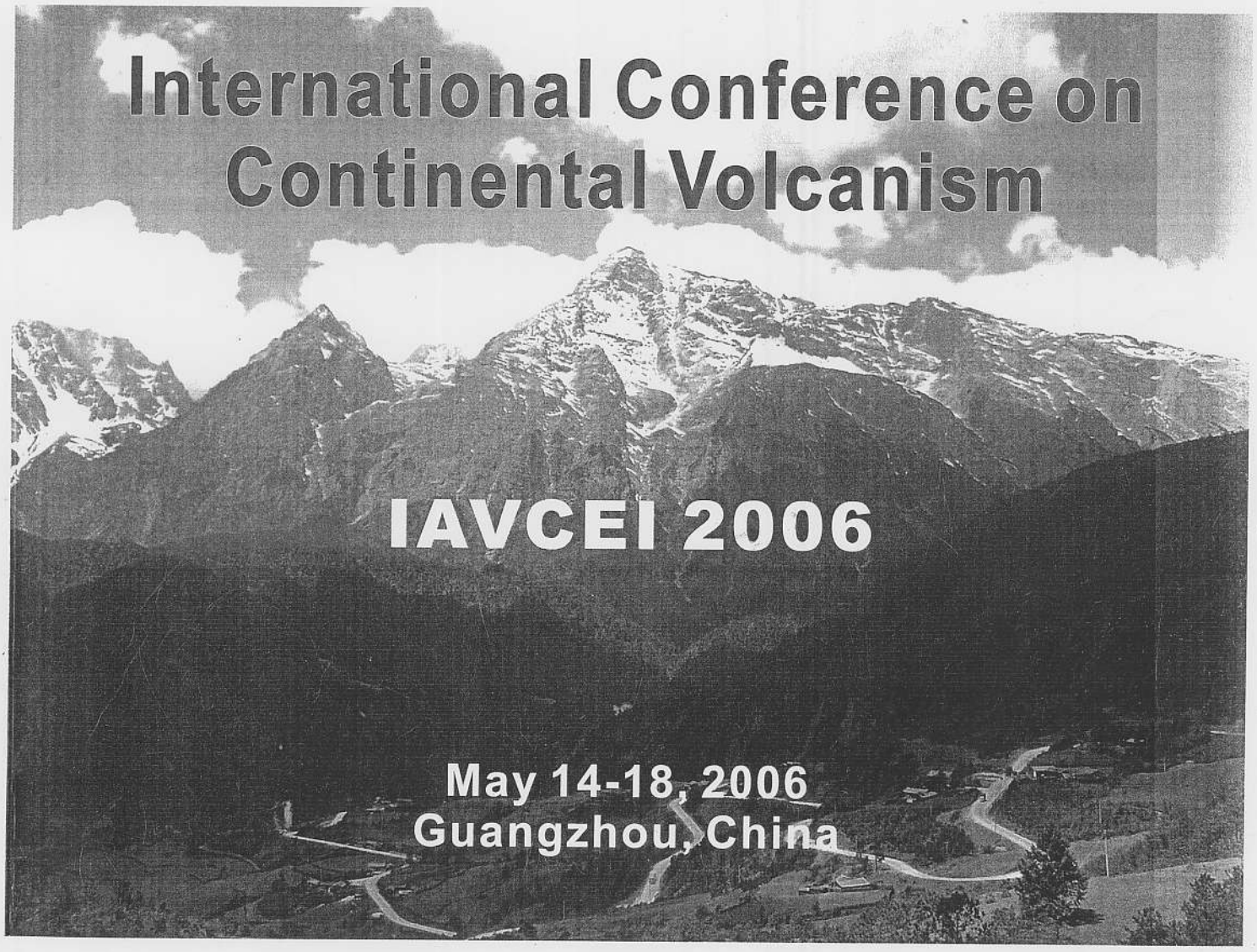

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Supplying lava eruptions in the Karoo Province, South Africa: a geochemical comparison of the volcanic sequence with intrusions in the main Karoo basin

J. S. Marsh and V.R Mitha

Department of Geology, Rhodes University, Grahamstown, South Africa

Magma supply for lava eruptions remains a poorly understood facet of continental flood volcanism. In the Karoo Province a vast complex of dolerite sheets and dykes is exposed in the main Karoo sedimentary basin underlying the flood basalt remnant of Lesotho (Drakensberg Group) suggesting that lavas were erupted locally from a widely distributed network of fissures. However, documentation of long distance magma transportation in the Ferrar Province and of lavas in the Columbia River Province which have flowed 100's of kilometres from their eruptive vents allows for the possibility that some Karoo basalt flows are unrelated to the underlying intrusions. This possibility has been suggested for the Golden Gate basalts of N Lesotho by Elliot and Fleming (2000) and can be further investigated by comparing the compositions of intrusions to those of flows building the geochemically-defined stratigraphic units in the Lesotho basalt sequence. Marsh et al.(1997) demonstrated that a number of thin geochemically-diverse units occur in the Barkly East Formation at the base of the Drakensberg Group. These units have limited areal extent and represent small-volume (< to <<1000 km^3) lava eruptions of local derivation. The overlying Lesotho Formation dominates the volcanic sequence and comprises widespread basaltic units of overall more uniform composition. From the base up these are the Mafika Lisiu, Maloti, Senqu and Mothae units, and each represent the availability of very large volumes (> to >>30 000 km^3) of geochemically more homogeneous magma. Dykes of a distinctive type, the Oxbow type, intruding the uppermost flows in Lesotho, have an erupted equivalent in the Springbok Flats remnant 400km to the N.

Geochemical data of some 224 samples of dykes (dominant) and sheets (minor) intruding the Karoo sedimentary sequence around the south, west and northern margins of the Lesotho remnant have been compared to the compositions of the lavas. Compositional diversity of lavas in the Barkly East Formation, allows magma types in the intrusions to be identified using the empirical approach of incompatible element ratio plots of Marsh et al. (1997). In the south dykes of the Moshesh's Ford (6 dykes) Vaalkop (2) and Kraai River(1) have been identified, all in proximity to lava outcrops of these types. Around northern Lesotho the following geochemical types of the Barkly East Formation have been recognised in the dykes: Wonderkop (2), Letele (3) and Oxbow (7). No dykes of the distinctive Golden Gate type have been found, either because it has eruptive sites remote (?Antarctica) from our sampling areas, or because intrusions of this low-volume magma type has been missed in our sampling. For the more uniform Lesotho Formation we have used Discriminant Function Analysis (DFA) to address the problem. First, we applied stepwise DFA to develop a discrimination model for 474 Lesotho Formation samples of known magma type affinity. The classification success rate is >98.7 % for the main Lesotho Formation types. We then applied this DFA model to classify the unknown intrusive samples and found that they correlate with all the main geochemical units of the Lesotho Formation. Thus, the bulk of the thick basalt lava pile in the main Karoo basin in southern Africa was probably erupted from a widespread network of fissures without long distance surface flow. Possible exceptions are the Golden Gate type as suggested by Elliot and Fleming (2000) and the Oxbow type. However, the nature and location of the deeper mantle-tapping supply systems remains illusive.