Does Bimodal Large Igneous Province occur in Geologic Record?: Insight from the Palaeoproterozoic Dongargarh Group, Central India

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EXTENDED ABSTRACT

The large igneous provinces (LIPs) are massive crustal segments, both oceanic and continental, where anomalously large volumes of melts have been emplaced. The LIPs, mostly of Phanerozoic age with rare Precambrian examples, are considered to be of two types: Mafic LIP (MLIP) and Silicic LIP (SLIP). The former are products of large scale mantle melting, whereas the latter (with <10% mafic rocks) are thought to be the products of crustal melting. The melt emplacements in MLIP probably taking place within 1-5 Ma, and for the SLIP, somewhat up to ~50 Ma. The LIP genesis is mostly ascribed to the thermal anomaly in the form of melting of deep mantle plume; the mantle providing the heat for the SLIP. Alternatively, fertile and fusible hetero-geneous shallow mantle melting, consequential to plate tectonic processes, is also discussed.

Bimodal magmatism is known for a long time in the literature. However, large scale emplacements of contemporaneous mafic-silicic melts (bimodal LIPs) are hitherto considered absent in the geologic record (e.g. Bryan et al. 2002). The main reason for this postulation perhaps was that large scale bimodality in LIPs was not predicted in the contemporary models. In this presentation, I would discuss bimodal LIPs do exist, the ~2.5 Ga Dongargarh Group in central India being the first reported occurrence of this type (Sensarma, 2005, 2007). And, such provinces call for large scale crust-mantle interactions, something not considered for LIP genesis so far.

Dongargarh Province: Key Characteristics

1. The volcanics-dominated Dongargarh Group (DG) form a structurally concordant sequence, being intruded by the Dongargarh Granite (DGr).
2. Sub-equal volumes of felsic pyroclastics (SiO_2 =72 wt%) and mafic lava flows; felsic rocks occur early in the sequence followed by three mafic volcanic formations interspersed with sedimentary horizons.
3. The mafic volcanic formations (Pitepani volcanics and more voluminous Sitagota volcanics) have interlayered high-Mg basalts (SiO_2 ~54 wt%, MgO ~7.5 - 12 wt%) and low-Mg basalts (SiO_2 ~49 wt%, MgO ~6 wt%) and are intrinsically similar in composition. Minor andesite/basaltic andesite (SiO_2 ~58 wt %) constitute the youngest mafic volcanic unit.
4. The DGr and the underlying felsic pyroclastics are products of same tectono-thermal event and thus approximately coeval. The felsic pyroclastics have low-δO^{18} (4-7‰) values and emplacement temperatures as high as ~900°C. Evidences suggest mingling of felsic-mafic melts, and thus undoubtedly their coeval nature too.
5. The DG roughly covers ~30000 sq km, with coeval DGr further add to the volume.
6. U-Pb single-crystal zircon data suggest formation of DG for ~40-50 Ma, comparable to SLIP.

Summary of new knowledge

1. Bimodal LIPs exist in geologic record, in addition to MLIP and SLIP.
2. Large scale crust-mantle interactions under common thermal perturbation gave rise to bimodal LIP.
3. Close interactions of crustal and mantle melts over longer duration (~50 Ma) in Dongargarh contrasts with contemporary models for LIP genesis.
4. Bimodal LIP in Donagargarh province denotes contributions of both crust and mantle in crustal growth at the Arcahean-Proterozoic transition.