THE TETHYAN TRIASSIC VOLCANISM : REMNANTS OF INTRA-OCEANIC ISLANDS RELATED TO THE OPENING OF THE TETHYAN OCEAN

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Abstract

Triassic volcanism is largely exposed in the Tethyan ranges and its tectonic setting is a matter of debate. Trace element and Nd, Sr and Pb isotopic chemistry of Triassic volcanic rocks from the Himalayas, Oman, SE Mediterranean and Albania will help to constrain the geodynamic setting of the widespread Triassic egneous event.

Keywords : Triassic Tethyan volcanics, tholeiite, alkali basalt, trace element geochemistry, Nd and Pb isotopes, OIB-type mantle source

Tectonic setting

Triassic volcanic rocks are closely asociated with Mesozoic ophiolites from the Central and Eastern Mediterranean (Serbian, Mirdita, Pindos, Antalya, Troodos, Baër Bassit) up to the Persian Gulf (Samail nappes in Oman) and Himalaya (Lamayuru nappe). Triassic volcanites constitute tectonic nappes generally sandwiched between the ophiolites and the Apulo-African, Arabian or Indian margin. They are stratigraphically associated with pelagic and/or reef limestones, which are spatially associated with Triassic, Jurassic, and Cretaceous sedimentary sequences recording the contemporaneous shallow to deep water evolution of the basin. The Triassic volcanic suite has been interpreted as remnants of a rifted volcanic passive margin or within-plate oceanic volcanoes.

Petrology and geochemistry of the Triassic volcanic suites.

In Himalaya ,the Drakkar Po Melange, exposed within the Indus-Tsan Po suture consists of exotic blocks of Upper Permian, Triassic and Cretaceous volcanic and sedimentary rocks, caught within a turbidite matrix. The Jurassic Spotang ophiolite is thrust upon the Drakkar Po Melange. The Triassic pillow basalts are associated with pelagic limestones. They display alkaline affinities: *i.e.,* $2.17 < TiO_2 < 3.38$, LREE- enriched $(2.75 < La/Yb)_N < 5.73)$ patterns and low La/Nb ratios $(0.36 < La/Nb < 0.77)$. Preliminary isotopic investigations suggest that the Triassic volcanics derive from an enriched OIB-mantle source devoided of crustal contamination.

In Oman, the Sumeini and the Hawasina nappes consist of imbricated sedimentary and volcanic units squeezed between the platform and the Samail ophiolite. They are respectively interpreted as continental slope and ocean basin deposits of the southern Tethyan Arabian margin at the end of the Paleozoic and the Mesozoic. Volcanism is dated as mid-Permian and Late Triassic. The Upper Triassic volcanics consist predominantly of pillow basalts associated either with Halobia- and Ammonites-bearing micritic limestones and shallow marine carbonates (reefs) or radiolarites and shales. Preliminary geochemical studies show that the volcanic rocks display intra-plate tholeiitic and alkaline affinities and a large range of εNd values.

In SW Cyprus, the Upper Triassic Mamonia volcanic suite consists of four types. Type 1 is composed of depleted olivine tholeiites, characterized by LREE-depleted patterns and multi-element plots with Th and Pb negative anomalies and no Nb and Ta enrichment or depletion relative to La. Type 1 basalts have εNd values (+7.5 to 5.4) that fall in the range of OIB while according to the Pb initial ratios, they plot in the N-MORB field. Type 2 exhibits typical features of oceanic tholeiite: slightly LREE-enriched, flat multi-element plots. Type 2 differs from Type 1 by significantly higher Pb isotope ratios. Both Types 1 and 2 are interbedded with deep-basin siliceous and/or calcareous sediments. Type 3 is composed of olivine-plagioclase-clinopyroxene phyric basalts and hawaiiites, which are strongly enriched in LREE, Nb, Ta and Th. The enriched nature of the mantle source of the alkaline rocks is confirmed by the εNd values (+6.4 to 3.4) and Pb isotope ratios which are the highest of all the Mamonia rocks. Type 3 is associated with Halobia-pelagic and reef limestones. Type 4 consists of trachytes, which are the most fractionated rocks of the Mamonia suite and shares with Type 3 similar εNd values and Pb isotope ratios. Trachytes occur as dykes intruding the alkali pillow basalts or restricted columnar-jointed flows resting on pillowed mafic flows.

In SW Turkey, the thick (1000 m) Upper Triassic volcanic pile is very well exposed in the Antalya Nappes. The predominantly pillowed flows are interbedded with Halobia and Ammonites-bearing limestones. The alkaline affinity of this mafic volcanism was demonstrated by various authors. New trace element and isotopic investigations show that most of the Upper Triassic volcanic rocks are mafic in composition and exhibit geochemical features of alkaline suites: high TiO_2, Nb, Ta and Th abundances, important LREE-enrichment and εNd values ranging between +5.1 and +4.4).

In NW Syria (Baër Bassit), the Upper Triassic volcanic rocks, interbedded with marls and Halobia-bearing limestones, are exposed within imbricate sheets of ophiolites and pelagic sedimentary rocks. Rare weathered mafic lava sequences are associated with Carnian-Norian calcilutite with red ribbon radiolarite intercalations, either in small lenses or surrounding horsts formed by reef limestones. The volcanism exhibits tholeiitic ($TiO_2 = 1.2$) to alkaline trends ($TiO_2 =$ 3.2 to 5.2. The La/Nb ratios (0.6 to 0.9) of the basalts range in the field of intra-plate volcanism.

In Albania, the volcanic rocks are exposed on both eastern and western sides and in some tectonic windows below the Mirdita ophiolitic nappe and belong to the "peripheral complex" or Guerret-Miliska zone. Micropaleontologic datation of sedimentary intercalations (Conodonts and Radiolaria) range from uppermost Permian to Upper Triassic with mainly Aniso-ladinian age. The rocks display ophitic, porphyritic or aphyric textures and include abundant calcite-filled vesicules. The dolerites consist of plagioclase phenocrysts set in a groundmass formed of plagioclase laths surrounded by clinopyroxene and Fe-Ti oxide. The porphyritic basalts consist of olivine and plagioclase phenocrysts set in an intersertal groundmass formed of quenched plagioclase microliths and oxides. The aphyric basalts include quenched needdle-shaped plagioclase in an abundant glassy groundmass. According to the sequence of crystallisation observed in the basalts (*i.e.*, olivine → plagioclase → clinopyroxene → oxides) the Triassic volcanism of Albania is tholeitic.

Conclusion

The Tethyan domain is characterized by an important and widespread Triassic volcanism which displays features of tholeiitic and alkaline suites. The Nd and Pb isotope compositions suggest that the Triassic volcanics derive from the partial melting of an OIB-type mantle. There is no evidence of the involvement of continental crust in the genesis of the rocks exposed in Cyprus and Turkey. According to paleogeographic reconstructions, the Triassic volcanism emplaced in narrow basins floored or not by oceanic crust, divided by continental blocks, interpreted as fragments rifted from the Gondwanian margin at the same time.