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Two contrasting modes of continental break-up associated with the formation of the Paleo- and Neo-Tethys in Iran: Implications for petrological and geodynamic evolution at a regional scale

Emilio Saccani (1), Michele Marroni (2), Luca Pandolfi (2), Khalil Allahyari (3), and Zohreh Azimzadeh (4)

(1) Dipartimento di Fisica e Scienze della Terra, Università di Ferrara, Ferrara, Italy (sac@unife.it), (2) Dipartimento di Scienze della Terra, Università di Pisa, Pisa, Italy, (3) Faculty of Earth Science, Shahid Beheshti University, Tehran, Iran, (4) Department of Geology, Faculty of Natural Science, Tabriz University, Tabriz, Iran

In Iran, two partial ophiolitic sequences, which are broadly classifiable as "Continental Margin Ophiolite" (CMO), record the tectono-magmatic processes that occur during the continental break-up preceding oceanic basin formation. They are represented by: (1) the Early Carboniferous Misho Mafic Complex (NW Iran) and (2) the Triassic sequences in the Kermanshah ophiolite (Zagros Belt) that are associated with the formation of the Paleo- and Neo-Tethys, respectively. Both CMO sequences consist of gabbros, sheeted dykes and basaltic lavas. Moreover, the Kermanshah CMO also includes exhumed sub-continental mantle lherzolites. Both sequences include rocks showing variable incompatible element enrichments, ranging from N-MORB to E-MORB, P-MORB and alkaline basalt compositions and are interpreted to have formed from partial melting a depleted MORB-type mantle source (DMM) metasomatized by variable proportions of plume-type, enriched components. Nonetheless, geological evidence and petrogenetic modeling suggest that the continental break-up of the Paleo- and Neo-Tethys occurred in two quite different ways.

The initial rift-drift tectonics of the Paleo-Tethys was triggered by a mantle plume activity and was strongly affected by plume-related magmatism and associated lithospheric weakening at a regional scale. This conclusion is consistent with the models proposed for the Paleo-Tethys margins in central-eastern Asia.

In contrast, the initial rift-drift tectonics of the Neo-Tethys was characterized by a type of rifted margin, which is intermediate between the amagmatic type (Ligurian Tethys type) and the magmatic, plume-influenced type. Indeed, likewise the Ligurian Tethys, rifting occurred through passive (possibly, asymmetric) extension, which led to the exhumation of the sub-continental mantle. Meanwhile, high Sm/Yb rocks formed at the continent-ocean transition zone by partial melting of a DMM source locally bearing sub-continental garnet-pyroxenite relics. However, in contrast with the Ligurian Tethys model, the Neo-Tethys rift stage was also associated with volcanism featuring a marked influence of plume-type components. Nonetheless, no geological evidence (e.g. regional doming, anomalous thermal regime, basaltic plateaux, magmatic evolution from more depleted to more enriched rocks, etc.) supporting the existence of a Triassic mantle plume activity in this area has been documented. Therefore, the plume-type geochemical signature observed in the Kermanshah CMO sequences can likely be explained with the re-activation of portions of enriched mantle (mantle heterogeneities) that were inherited from the Paleozoic mantle plume associated with the opening of Paleo-Tethys.