Copper mineralization prevented by arc-root delamination during Alpine-Himalayan collision in Iran

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The formation of Cu-Au-Mo porphyry deposits in Iran is linked to continental collision, yet there are no clear temporal relations between geochemical signatures of Miocene (collisional) and Eocene (pre-collisional) intrusive arc rocks, and the presence/lack of ore mineralization. We compare geochemical scenarios from five different segments along the Urumieh-Dokhtar arc and propose a geodynamic model to explain this discrepancy. For instance, in the Natanz arc segment in central Iran, contrasting geochemical signatures of copper ore hosting Eocene and some barren undeformed Miocene diorites to granites temporally overlap with the Alpine-Himalayan collision. These changes provide key implications on the existence and lack of Cu mineralization during collisional magmatism. High Sr and low Y (and Yb) contents of Eocene arc rocks in the Natanz arc segment reflect thickened, Andean-type orogenic arccrust (~45 km), whereas barren Miocene Natanz arc rocks (21-19 Ma) indicate thin arc crust similar to collisional volcanism in Anatolia. Geochemical modeling indicates a change in the mineralogy of the melt residual, from precollisional Eocene basaltic garnet-bearing (5-30%) amphibolite to syn- or postcollisional Miocene metasomatized mantle peridotite, which can be explained by collision-induced delamination of the arc lithospheric root. Subsequent recharge of hot asthenosphere and melting of metasomatized mantle peridotite and lack of interaction with a garnet-bearing arc crustal keel explain the low Sr and high Y (and Yb) contents, the relatively enriched initial Sr isotope ratios of postcollisional Miocene Natanz rocks, and the lack of copper mineralization in postcollisional Miocene Natanz arc rocks. Arc-root delamination removes the copper- and sulfurenriched metasomatized lithospheric arc root and hydrous cumulate reservoir required to form copper ore deposits. Lack of the dense melt residues also provides an alternative explanation for the elevated, thin crustal Iranian back-arc plateau (38 km) as a result of uplift by isostatic rebound rather than uplift by anomalous shortening. Miocene arc-root delamination implies a minimum age of >21 Ma for the Alpine-Himalayan collision in central Iran.

Relationship between modern speleothem formation and surface weather in an Asian tropical cave

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For precise climate prediction, it is necessary to reconstruct high time and space resolution paleo-climate (especially past 2000 years) from paleo-climate proxies and assimilate the result to climate model. Tropical Asia, including Indonesia, is well affected by El Niño Southern Oscillation (ENSO). The ENSO does not only directly affect on precipitation in tropical Asia, but also indirectly on middle and high latitude climate through teleconnection [1]. In Indonesia, Watanabe *et al* [2] suggested inverse-correlation between $\delta^{18}O$ and $\delta^{13}C$ in speleothems and instrumental precipitation. However, relationship between modern speleothem formation and surface weather is not revealed clearly.

Thus cave monitoring program was initiated from 2011 in Petruk Cave (Central Java, Indonesia) in order to study the recording mechanism of precipitation variation into the $\delta^{18}O$ and $\delta^{13}C$ fluctuation in speleothems.

Air CO_2 concentration in Petruk Cave is fluctuated daily and seasonally until over 100 m deep site from the entrance.

It is revealed that cave air CO_2 concentration may be a significant factor that controls stable isotope value in speleothems, because temperature, humidity and drip rate in Petruk cave are nearly stable.

A scenario of precipitation recording is as follows: (1) surface rainfall cools outside air temperature; (2) cave airflow direction is inversed; (3) outside fresh air flows into the cave and air CO_2 concentration is dropped; (4) pCO2 difference between cave air and dripwater becomes higher and calcite precipitation is promoted; (5) $\delta^{18}O$ and $\delta^{13}C$ in speleothems are decreased.

[1] Hastenrath (1991) *Climate dynamics of the tropics*. [2] Watanabe *et al* (2010) *Palaeogeography, Palaeoclimatology, Palaeoecology* **293**, 90–97.

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