SPATIAL DISTRIBUTION OF MINERAL DEPOSIT ALONG EASTERN MEDITERRANEAN SUBDUCTION ZONE: A LINK WITH 3D MANTLE FLOW ASSOCIATED WITH SLAB “ROLLBACK”?  

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SUMMARY  

Relationship between ore genesis and plate tectonics are now well established as evidenced by the strong correlation between plate boundaries and ore deposit distribution (e.g., Pereira and Dixon, 1971; Mitchell and Garson, 1972; Sillitoe, 1972b).  

At Tethysian convergent margin, mineralization is seen along past subduction zone where a large variety of copper and gold deposits are directly related to the magmatic activity associated with subduction mode (see figure 1).  

During the Late Mesozoic, semi-continuous spatial distribution of Cu deposits (i.e. from Romania to Eastern Turkey) is mainly characterized by porphyry deposit type (Fig. 1A). Deposits distribution is along continuous past subduction zone.  

The Palaeogene mineralized belt is poorly constrained and extends from Hungary to Afghanistan with scattered clusters of copper-gold porphyries, skarns and epithermal deposits (Fig. 1B) related with the localization of the past subduction/collision zone.  

Neogene deposits distribution is discontinuous that is probably related with subduction zone segmentation and events. From the western to the eastern Tethys, we identified (i) mainly gold mineralized districts with epithermal systems and the retreating subducting lithosphere, (ii) the Arabian collision at the end of Miocene and a gap of mineralization probably related, (iii) and copper deposits mainly concentrated in large porphyry systems found at the south-eastern extremity of the belt where an Andean type subduction is suggested (Fig 1C).  

These three main stages of metallogenic evolution seem to be related to Neothethys closure and induced subduction dynamics changes (Fig 1).
Particularly, magmatism and ore deposit spatial distributions in SE Europe occur in relatively narrow belts that can be correlated to Hellenic subduction dynamics. We noticed the apparition of epithermal gold and porphyry-type deposit of late Cenozoic age in SE Europe along extensional settings (Mitchell and Carlile, 1994, Mitchell, 1996). Deposits are probably associated with high potassium calc-alkaline volcanic complexes in Aegean and western Turkey (see figure 2).

Therefore, spatial correlation exists and indicates the existence of anomalous warmer domains under overriding lithosphere (Pe-Piper and Piper, 2007, Dilek and Altunkaynak, 2009) created by either subducting lithosphere tearing (de Boorder et al., 1998; Govers and Wortel, 2005) or by delaminating (Davies and von Blanckenburg, 1995; Regard et al., 2003).

The striking feature of Hellenic slab is a narrow convex arc shape. This curvature is more likely the response of the slab retrograde motion in a toroidal component of the 3D return flow (Funiciello et al., 2003; Morra et al., 2006; Schellart et al., 2007; Loiselet et al., 2009). The 3D return flow associated with slab rollback process, observed in nature, such as for example in the Scotia, Tonga and Indonesia subduction zone, has two components (1) a toroidal component where streamlines are subparallel to the slab surface (i.e., in a horizontal plane) and (2) a poloidal component (down dip, in a vertical plane) (see figure 3).

Previous studies have focused on the role of the mantle flow component only in the poloidal plane (i.e., the subduction plane) to identify warmer anomalies under overriding plate in order to explain tectonics, volcanism and ore deposits related (de Boorder et al., 1998).

Here, we explore the idea which heat source is provided by a 3D asthenospheric mantle flow associated with the retreating Hellenic slab since at least 20 Ma (Jolivet and Brun, 2010). We propose to identify toroidal component such as one of parameters responsible of the subduction zone dynamics and ore deposits distribution related.
Dynamical models of the subduction system are processed to provide new insights into the temporal evolution of such system. We focus our study on the controls exerted by the properties and geometries of the retreating slab and the rheology heterogeneity in the mantle in order to define potentially abnormal warm zone along subduction system. The confrontation between compilation of available geophysical data such as seismic tomography, seismic anisotropy and calculated mantle flow velocities, identification of Cu-Au mineralizations distribution and the analysis of temporal and spatial constraints given by modeling, allow to identify one of the main dynamic processes responsible for shallow effects in the crust connecting i) relatively short-lived regional igneous and hydrothermal activities and ii) the formation of related mineralization.

References


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