Spatial and temporal distribution of Cu-Au-Mo ore deposits along the western Tethyan convergent margin: a link with the 3D subduction dynamics

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Emplacement conditions of mineralized systems in subduction and post-subduction environments and the sources of metals such as Cu, Mo and Au have been considered in the past. However, despite their importance in exploration strategies at the continental scale, interrelationships between distribution of ore systems and subduction dynamics are still partly unclear.

Along the western Tethyan convergent margin, where Tertiary subduction history is well constrained, porphyry, epithermal and skarn ore deposits show a variable evolution of their spatial distribution.Using different and complementary database on European and Middle East ore deposits, threemetallogenic episodeshave been highlighted: (1) a late Cretaceous – Paleocene phase characterized by a copper mineralization within the Balkan chain and in the Kaçkar mountains (eastern Turkey), (2) an Eocene phase with a few copper ore deposits in eastern Turkey and small Caucasia and (3) an Oligocene – Neogene phase with a more southern distribution along the margin and mainly constituted by epithermal Au systems in the west (Carpathians, Rhodope, Aegean and western Turkey) and by porphyry copper deposits in the east (Zagros).

These changesare suspected to be controlled by complex and evolving subduction dynamics.Using paleogeographic tools, it turned out that, in the eastern Mediterranean area, the late Cretaceous – Paleocene and Oligocene – Neogenemetallogenic episodesarecoeval with a significant decrease of the Africa – Eurasia convergence rate, from about 1.5 to 0.4 cm/yr. Indeed, compressionaltectonics in the volcanic arc domain, associated with a high convergent rate, promote the storage of large volumes of metal-rich magma and the

development of an extensive MASH (melting, assimilation, storage and homogenization) zone. When this convergence rate decreases, a stress relaxation occurs in the overriding crust, inducing the ascent of a sufficient flux of this fertile magma and allowing the formation of numerous mineralized systems within the upper crust.

The Au-rich Oligocene – Neogenemetallogenic episode in the eastern Mediterranean region is also correlated with an increase of mantle-derived and/or subduction-modified lithospheric mantle components in magmas. This feature may be a consequence of the emplacement of hot asthenosphere at shallow depth related to (1) the development of a wide back-arc region due to slab retreat such as in the Aegean domain and (2) a slab tear and/or a lithospheric delamination, suspected notably in the Carpathians and western Turkey where alkaline to shoshoniticvolcanism occurs.

As the behavior of the slab and asthenosphere below the upper plate seems to play a key-role in controlling the distribution of ore deposits, it is worth studying the dynamics of the 3D mantle flow related toslab retreat.Thus, 3D numerical models of subduction dynamics with realistic rheologies have been developed.Around the slab edges, the poloidal (i.e. in a vertical plane) and toroidal (i.e. in a horizontal plane) components of the mantle flow in subduction zone appear to depend on the slab rollback to plate velocity ratio. Heat and mass transfersinduced by such 3D mantle flow, promote thermal anomalies in back-arc domain, observed on seismic tomographic models and necessary to produce fertile magmatism.