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Geochemistry of the Mediterranean Mantle – geodynamic Implications

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The diversity of Cenozoic igneous rocks in Italy reflects unusual and heterogeneous mantle sources. Such a mantle must be capable of generating: i. silica-undersaturated melts, ii. melts rich in volatiles (carbonatites), and iii. melts that can have anomalous trace element signatures accompanied by high K contents. Although a subduction-related tectonic setting has long been suggested, many of the volcanic rocks in Italy are, in fact, similar to those associated with intra-plate magmatism. Evidence for the chemical composition of the Mediterranean mantle can be gleaned from mantle xenoliths and from elemental and isotopic data of magmatic products. Four geochemical features stand out. First, many rocks have high Mg#s suggesting the involvement of a primitive mantle source. Second, many of the rocks also have Nb, Ta and Ti troughs in normalized multi-element diagrams. Third, some of the rocks are extremely enriched in K. And finally, the rocks have extremely variable Pb, Sr and Nd isotopic signatures. Unfortunately, the use of elemental abundances in discriminating sources is limited because compositions are controlled by source mineralogy, degrees of partial melting, polybaric crystallization and magma differentiation. Radiogenic isotopes remain relatively unaffected by these processes and help provide constraints into mantle evolution, mantle mixing and source characteristics. Recent interpretations of the isotope systematics of a newly compiled Sr, Nd and Pb isotopic data base, including unpublished data, suggest binary mixing involving three distinct end-members. Two of the three end-members are similar to those found in oceanic basalts (EM1 and a FOZO-like component), while the third (ITEM, Italian enriched mantle) is characterized by a high $^{87}Sr/^{86}Sr$ of about 0.7220 reflecting either a deep-mantle source with a high,

time-integrated Rb/Sr ratio, or involvement with pelagic sediments. The presence of a common isotopic component (ICE, Italian common end-member), similar to FOZO, in almost all of the volcanic rocks in Italy points to a single, unified geodynamic system. This common end-member is similar to the LVC (low velocity component), EAR (European asthenospheric reservoir) and CMR (common mantle reservoir) already proposed for parts of the sub-lithospheric mantle underlying much of Europe. The presence of three, distinct, isotopic end-members rules out episodic periods of metasomatism and melting associated with downgoing slabs as has been suggested by other authors. None of the three end-members from Italy have isotopic signatures similar to GLOSS (global subducting sediment) that characterize present-day subduction zones, to MDST (modern deep sea turbidites), or any isotopic end-member associated with convergent plate margins. In addition, HIMU (see Cadoux et al., EPSL, 2007), DMM, and EM2 can be ruled out as major players in Italian Cenozoic magmatism. The various components involved in mixing can reflect either a “streaky” mantle source, metasomatized mantle, or an inhomogeneous plume. The model, already published, for the Western Mediterranean that best fits the isotopic data involves the progressive eastward growth of a plume head trapped within the transition zone generating metasomatism, magmatism, and stretching of the overlying lithosphere (Bell et al., 2006; Lavecchia and Creati, 2006; Annal. Geophys., 49).