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Magma mixing in El Hoyazo volcanics, Betic Cordilleras (SE Spain)

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The Neogene Volcanic Province (NVP) of SE Spain attests for partial melting in the continental lithosphere of the Alborán domain around 20-2 Ma, contemporaneously to the thinning of the Betic Cordilleras. The volcanics show a variety of rock types and geochemical affinities, including tholeiitic basalts, calc-alkaline basaltic andesites to rhyodacites, strongly peraluminous andesites and dacites, shoshonitic rocks, lamproites, and alkali basalts (e.g. Benito et al. 1999). Previous studies have proposed several petrogenetic scenarios for the volcanics, in clear connection with current uncertainty in the geodynamic scenario for the Alborán region. These models include arc magmatism associated with slab roll-back (Duggen et al. 2004), delamination or convective removal of Alboran lithosphere after crustal thickening (Platt and Vissers 1989; Seber et al. 1996; Turner et al. 1999), or slab break-off and sinking after subduction (Zeck et al. 1992). Previous studies have shown that NVP magmas with different geochemical affinity coexist in time and space (e.g. Duggen et al. 2005). Hence the possibility of magma mixing exists, which may potentially complicate even more elucidating the petrogenesis of the volcanics. We report preliminary results on a detailed petrologic and geochemical study at El Hoyazo volcano, in the NVP. The volcano is made of strongly peraluminous, graphite-bearing dacites, which host frequent (1-2 vol. %) enclaves of anatectic metapelites and mafic, gabbroic to basaltoid enclaves (Zeck, 1992). Host dacite has a phenocryst assemblage made of plagioclase, biotite, quartz, cordierite, ilmenite and scarce sillimanite, as well as abundant xenocrysts of almandine-rich garnet, cordierite, hornblende, orthopyroxene, quartz, plagioclase and spinel (Zeck 1992). Whole-rock analyses of matrix dacite are comparable to

metapelite averages (e.g. Al_2O_3 ≈16.9 wt%, Fe_2O_3 ≈5.1 wt%, MgO≈1.9 wt%, K_2O≈3.3 wt%) except for somewhat lower ASI (≈1.46) values and slightly higher CaO (≈2.7 wt%) and Na_2O (≈1.9 wt%) concentrations. Silicate glass in the matrix of metapelitic enclaves has a peraluminous leucogranitic composition (SiO_2 ≈70.1 wt%, FeO_t+MgO+TiO_2 ≈1.7 wt%, ASI≈1.22). Mafic, gabbroic to basaltoid enclaves display sharp contacts with host dacite, and show a very variable mineralogy composed of Pl+Bt±Hbl±Opx±(Cpx)±Cumm±Qtz±glass, resembling vaugneritic and/or appinitic enclaves in granitic systems. They present a variety of microstructures, including vesiculated glass-rich, microlitic rocks with fine-grained chilled margins, glass-bearing coarse-grained rocks with large skeletal interlocking crystals of biotite or hornblende, or completely medium-grained holocrystalline rocks with late poikilitic plagioclase and quartz crystals. Textural evidences indicate that many of the inclusions were intruded in the host magma as essentially liquid blobs. Mineral chemistry and textural complexity strongly suggests a relatively prolonged history of intrusion of several mafic pulses into the dacite magma. It is proposed that repetitive intrusions of hot, hydrous mafic magmas in a partially crystallized dacite magmatic system may have induced rejuvenation, remelting, mobilization, and finally convective overturn of the magma chamber, resulting in the final homogenization of the host magma and dissagregation of previous mafic enclaves. A last batch of hydrous, andesitic magma injected in the dacite magma chamber may have caused the eruption. The major element composition of mafic enclaves corresponds to basaltic andesites and andesites. When compared with the nearby Cabo de Gata andesites, they show higher contents in water, MgO (≈4-9 wt%), TiO_2(1.2 wt%), K_2O (≈1-4 wt%), P_2O_5, Rb, Sr, Ba, Ni, Zr, Th, U and LREE, and lower SiO_2, Al_2O_3 and Na_2O. Some degree of interaction between host dacite and mafic enclaves is indicated by hornblende and orthopyroxene xenocrysts in the host peraluminous dacite, as well as presence of metapelitic enclaves and embayed quartz lumps within the mafic enclaves (Zeck 1992). However, major and trace element composition and trends in variation diagrams indicate that, prior to intrusion into the dacite host magma, the mafic magmas were probably produced by mixing or interaction between a calc-alkaline, andesitic end-member, and an enriched, potassic-magnesic end-member, tentatively a rock with lamproitic affinities. Later mixing between intruded mafic magmas and host dacite and/or leucogranite melt within metapelitic enclaves was very limited and did not significantly modify the geochemistry of the mafic enclaves (e.g. ASI≈0.95).