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The mechanisms of crustal anatexis in Nature from the study of metapelitic xenoliths within El Hoyazo dacites, SE Spain

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Anatectic xenoliths within the Neogene El Hoyazo dacites, SE Spain, offer the possibility of investigating the mechanisms of crustal anatexis and the role of kinetics on the composition of natural anatectic melts. The study entails compositional analysis of silicate glass in the matrix and as inclusions in several different host minerals. The natural glasses are compared with current experimental data on mineral-melt equilibrium and the kinetics of melting. Previous petrologic studies indicate that the metapelitic xenoliths represent partially melted rocks at peak (temperature) conditions of 800-850^{o}C and 5-7 kbar, brought rapidly to surface within the host dacite while they were still in a partially melted state.

Silicate glass within the xenoliths is present as glass inclusions (MI) in all mineral phases and in the rock matrix. Textural studies indicate that MI are either primary and/or pseudo-secondary. The most (only?) significant modification of the xenoliths during the rapid exhumation path corresponds to the crystallization of skeletal micron-sized alkali feldspars from matrix glasses and in MI within plagioclase. The major element compositions of matrix glass and MI within plagioclase, garnet, cordierite and ilmenite are granitic but slightly different and characteristic of each textural situation. Glasses in all textural locations display trends in Harker diagrams, including a conspicuous decrease in H_2O (EMP difference method) with increasing SiO_2 concentrations. Glasses in each textural location plot as differentiated clusters in pseudo-ternary quartz-albite-orthoclase wt % normative space, around the 5 kbar H_2O-undersaturated

(a_{H2O}=0.3-0.1) haplogranite eutectic or within the quartz field though close to the eutectic. A trend exists from more to less evolved (lower SiO_2 and H_2O, higher FeO and CaO) glasses from the quartz field to the nearly-dry eutectic.

Explanations for the systematic differences in glass composition among textural locations and trends in Harker diagrams include: (i) local heterogeneity produced during growth of the host phases (glass should be depleted in mineral components of the host); (ii) differences produced after entrapment due to further dissolution of the host during heating, or partial crystallization of the liquid upon cooling; (iii) differences produced after entrapment due to H loss via diffusion throughout the host mineral phase; (iv) homogeneous liquids in equilibrium with the restite were trapped along the super-solidus path of the enclaves (largely during pro-grade anatexis); or (v) a combination of all or part of the above processes. We have modeled processes (i) to (iii), and have concluded that, individually or in combination, these cannot explain all the compositional trends and differences among textural locations. The most likely explanation seems to require entrapment of heterogeneous melt compositions by processes other than (i). Data on precise equilibrium melt compositions during prograde anatexis are not common, especially for quartz-poor pelites like the current samples. Data on the kinetics of melting of pelites are not available either. Though further comparison with results from already planned experimental programs on the above topics will provide more clues, we infer that glass composition heterogeneity within El Hoyazo xenoliths corresponds to some extent to the variation in melt phase composition along the prograde melting path of the rocks. This is in accordance with textural observations on the sequence of crystallization of mineral phases and the chemistry of MI within them.