Geophysical Research Abstracts, Vol. 9, 02249, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02249

Sodalite: A pressure indicator in phonolitic magmas

J. Andújar (1), F. Costa (1) and J. Martí (1)
(1) Institute of Earth Sciences "Jaume Almera", CSIC, Barcelona, Spain.

The pressure, temperature, and volatile contents at which magmas are stored are key main parameters in determining the eruption characteristics and, consequently, for assessing volcanic hazard. The volatile content and composition determine the physical properties (e.g., density, viscosity) of the magma and the possible explosive character of the eruption. Pressure controls the volatiles-melt solubility. Pressure is a difficult parameter to determine, and phase equilibria experiments are still the most reliable method. Here we present new experimental results and combine them with those of the literature to show that the stability of sodalite, a mineral present in many peralkaline magmas, is also highly pressure dependent and thus a good marker of the magma storage depth prior to eruption.

As starting material we used a phonolitic pumice from the 190 ka El Abrigo caldera-forming eruption from Tenerife (Canary Islands, Spain). Experiments were performed using cold seal pressure vessels working vertically, equipped with a rapid quench system and working under an oxygen fugacity one log unit above the Ni-NiO buffer. We explored a pressure range between 50 to 200 MPa with runs performed at 50 MPa intervals, whereas the temperature was varied between 700 and 900ºC, at intervals of 50ºC or 25ºC. Experiments were conducted at water saturated and undersaturated conditions. Main findings are: (1) sodalite is only stable below 900 ºC, and (2) the pressure range at which sodalite is stable depends on the water content. At 825ºC and water saturated conditions, maximum pressure is 1250 MPa, whereas at 825ºC and for XH_20 = 0.5 the stability field increases, to about 1750 MPa.

Our experimental results reveal that sodalite stability is highly pressure sensitive. This can be explained by the fact that sodalite requires Cl (a volatile element) to be stable. Since Cl solubility increases with decreasing pressure the presence of sodalite marks the maximum pressure of magma storage. This is in contrast with the presence of amphibole and water solubility in magmas, which provide the minimum pressures.

Application of sodalite as a geobarometer in the case of Tenerife has revealed that the shallow magmatic system has moved from shallow to deep pressures from the Las Cañadas complex to the present Teide-Pico Viejo system. This change in the depth of the subvolcanic phonolitic system could explain the difference in the eruptive style between the pre-Teide, Las Cañadas central complex (mostly explosive) and the present Teide-Pico Viejo volcanic complex (mostly effusive).