

Metasomatically induced alteration and re-equilibration of orthophosphate and silicate minerals: Textures, fluids, and mass transfer

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In nature, total re-equilibration of minerals and mineral assemblages under prevailing P-T-X conditions is greatly enhanced when suitably reactive fluids are involved. Oft times, however, re-equilibration is only partial and limited to those areas of the grain in immediate contact with the fluid. This can be due to a variety of factors including limited amounts of fluid, a limited reactivity between the fluid and the mineral and/or sufficiently low P-T conditions thus guaranteeing very low reaction rates. In general re-equilibration, whether localised or total, occurs as a result of dissolution-precipitation processes, which can also allow for the nucleation and growth of mineral inclusions of one phase within minerals of another phase.

Here a series of different orthophosphate and silicate mineral textures with or without mineral inclusions will be described and interpreted. Each of these textures is the direct result of fluid-induced dissolution-precipitation processes and represents the re-equilibration of the orthophosphate mineral on a localised scale. Such re-equilibration textures can have profound implications with regard to dating metasomatic events as well as allowing for P-T-X conditions to be estimated.

From a broader perspective, these fluids have not only interacted with the orthophosphate and silicate minerals but also potentially with the rock as a whole. As a consequence, the documentation and interpretation of metasomatically induced alteration in orthophosphate and silicate minerals has broader implications with respect to obtaining deeper insights into the nature and role of fluids in the crust and upper mantle.

LIBS: A new paradigm for real-time and in-field geochemical analysis

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Laser Induced Breakdown Spectroscopy (LIBS) is a simple atomic emission spectroscopy technique capable of essentially non-destructive determination of the elemental composition of any substance in real time. In LIBS, a focused and pulsed laser beam is directed at a sample surface, where laser energy absorption and resulting material ablation produces a high-temperature microplasma at the sample surface. Small amounts (nanograms) of material are dissociated and ionized, with both continuum and atomic/ionic emission generated by the plasma during cooling. A broadband spectrometer equipped with a CCD array detector can be used to spectrally and temporally resolve the light from the plasma to record emission lines of the full suite of elements present in the sample.

Important attributes of a LIBS sensor system for geochemical analysis include (i) real-time response, (ii) in-situ analysis with no sample preparation required, (iii) a high sensitivity to low atomic weight elements which are often difficult to determine by other techniques, and (iv) standoff detection. LIBS technology is now sufficiently mature, inherently rugged, and affordable to offer a capability for both laboratory and field-deployable analysis. Successful laboratory benchtop and 30-m standoff feasibility studies have been conducted that highlight the potential of LIBS for variety of geochemical, mineralogical, and environmental applications that require either real-time or in-field chemical analysis.