"Experimental techniques for the study of hydrothermal fluids and silicate melts"

Fluids and melts are the primary agents of mass transfer within the Earth. They redistribute elements by preferential extraction, transport and concentration, leading to enrichments and depletions. The results range from geochemical signatures that are characteristic of geological settings or processes to economically important ore-deposits. Fundamental to interpreting the resulting geochemical information is an understanding of how chemical and physical variables affect the behaviour of elements in hydrothermal fluids and silicate melts.

The key to studying fluids and melts is the ability to undertake experiments in situ at temperatures corresponding to natural processes. This is essential for fluids since dissolved species commonly precipitate on cooling and changes in speciation may occur. For melts, while important information can be obtained from glasses, structural changes occur below the glass transition temperature and some trace element oxidation states are not quenchable. These chemical and physical changes in fluids and melts between the conditions of interest and ambient represent long standing constraints to advances in the field. Recently, new experimental approaches that utilise novel sample cells and a variety of spectroscopic methods have emerged enabling these problems to be addressed. In particular, the increased availability of synchrotron radiation sources is allowing the speciation of elements in fluids and melts to be directly investigated. These new experimental approaches are providing data under conditions that were previously considered to be inaccessible.

The study of hydrothermal fluids has been inhibited in the past by the difficulty of constructing sample cells capable of withstanding the vapour pressure of water at magmatic temperatures. Three approaches to this problem are presented in this volume: natural fluid inclusions, novel solution cells, and the hydrothermal diamond anvil cell (HDAC). In each case X-ray absorption spectroscopy (and in one study Raman spectroscopy) was used to determine the speciation of metals in situ at temperatures up to 700 ˚C. The HDAC was also used in conjunction with synchrotron radiation induced X-ray fluorescence (XRF) to investigate in situ trace element partitioning between fluids and melts. Studies of melts highlight the use of soft X-ray spectroscopy to probe the structure of glasses, synchrotron XRF to determine trace element diffusion, the falling sphere method to measure melt viscosity, and Raman spectroscopy to investigate speciation in glasses. Taken together, the contributions provide an overview of experimental approaches being used to study fluids and melts and showcase the advances that are now being made in the field.

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