Fluid and melt inclusion evidence for immiscibility in nature

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Immiscibility is an important physical process that results in the partitioning of chemical components in many geologic environments. Fluid and melt inclusions trapped in these environments provide direct evidence for immiscibility, and can be used to estimate partitioning behavior of various components in these systems as a function of temperature and pressure. Specifically, in many ore-forming environments its is the presence of immiscibility, or lack thereof, that determines whether economic concentrations of metals are deposited.

In sedimentary basins oil-water-gas immiscibility generates low-density hydrocarbons with transport properties that allow the physical separation of oil and gas from oilfield brines. Analysis of coexisting aqueous and hydrocarbon inclusions provides valuable information concerning the pressure (depth) and timing of hydrocarbon generation and migration.

Numerous studies of magmatic – hydrothermal systems document the link between the deep and shallow environment, and the role of immiscibility in producing economic mineralization. Immiscibility in the deep magmatic hydrothermal environment results in the partitioning of Cu, Au, Tl, Hg, Sb, As , S and other volatile components into the vapor phase. These components are transported into the shallow epithermal environment where loss of sulfur results in deposition of Au to produce economic precious metal mineralization.

Various types of melt – melt immiscibility have been recognized in igneous systems, including sulfide – silicate, silicate – carbonate and silicate – silicate immiscibility. Sulfide melt – silicate melt immiscibility has been recognized as an important process in the formation of many types of magmatic and magmatic-hydrothermal deposits because it determines the Cu/Au ratio in the sulfide ore.

Fluid inclusion evidence for these and other examples of immscibility in high temperature systems will be summarized, and the implications for chemical fractionation and the generation of economic occurrences of resources will be considered.