Fluid and melt inclusions as recorders of the earth's dynamic history

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Fluid and melt inclusions represent microscopic samples of fluids trapped in minerals either during or after their formation. Using analytical techniques that have been developed and improved during the past few decades, it is now possible to determine both the temperature of formation and the composition of the fluids in these inclusions. In addition, the pressures (or depths) of formation can be estimated by interpreting these results within the framework of PVTX data for the appropriate fluid system. In recent years, major advances in our understanding of processes associated with hydrocarbon generation and migration, mineral deposit formation, evolution of magmatic systems, deep crustal processes and the important role of fluids in subduction zones and in the upper mantle have resulted from studies of fluid and melt inclusions. From a practical point of view, these results can be applied effectively in exploration for mineral and energy resources.

Perhaps the most significant advance in our understanding of ore-forming processes during the past half-century has come from studies to determine the metals content of the ore-forming fluids and how the concentrations evolve during mineralization. These data, integrated with microthermometric and paragenetic information, allow us

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to constrain, in many cases, the depositional mechanisms. For example, detailed studies of porphyry copper deposits show clear trends in copper contents with temperature that suggest temperature decrease is the dominant depositional process in these deposits, an interpretation that is supported by both stable isotope and alteration data. As another example, detailed fluid inclusion studies of epithermal precious metals deposits have documented a clear genetic relationship between gold and/or silver deposition and boiling of the hydrothermal fluids in many (but not all) deposits. As such, fluid inclusions provide an effective means to explore for and vector towards hydrothermal systems that have the capability of producing economic mineralization.