Fluid histories in sedimentary settings revealed using multiple in situ micro-analytical techniques

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Fluids are responsible for many post-depositional/emplacement processes in sedimentary rocks, such as cementation, alteration, and mineralisation (Cu, Zn Pb), and it is critical to understand the characteristics of such fluids in order to interpret properly these processes. Advances in in situ micro-analytical methods (SIMS, LA ICP-MS) now allow detection and assessment of geochemical variations at the micron-scale. Integration of these methods with fluid inclusion (FI) thermometric and evaporate mound (SEM-EDS) analyses provides the means to generate a more thorough, complete, and paragenetically constrained dataset than using the traditional bulk analysis approach, which averages out changing geochemical signals.

The multi-analytical in situ approach presented here, which will be illustrated with examples from several settings, demonstrates the power of integrating multiple data sets to overcome the limitations inherent to each individual method. This approach also provides a more detailed and continuous geochemical history than is obtained using traditional methods. In addition to providing higher-resolution analytical detail, the approach permits using information from one technique to constrain data obtained using another technique. For example, FI thermometirc data provide limitations for oxygen isotope calculations, which then can yield the water-rock ratio experienced by the fluid, which can be used to interpret shale-normalised REEY patterns. In addition, FI salinity and evaporate mound results can also be used to interpret REEY data (e.g., Ce anomalies) and $\delta^{18}O_{H2O}$ values more effectively, and thus characterise reservoirs and fluid-rock interaction better.