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A new Provenance tool for the exploration of unconventional plays: the provenance and mineralogy of silt.

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Provenance petrographic analysis has traditionally focused on the sand fraction as thought to be the most useful because both conglomerates (too proximal to the source) and silt (to faraway from the source) provide limited information. However, it important to recognise that the silt transported in suspension actually represents the majority of the sediment transported by large river systems and the predominant grain-size in major deltas and submarine fans, as well as in most of ancient sedimentary basins and reservoirs.

The standard routine to determine the composition of the silt and clay fractions consists of the application of a series of geochemical techniques to analyse major and trace elements and REE (Rare-Earth-Elements). Data are then generally plotted onto tectonic setting discrimination diagrams and parent rocks are generically identified only in terms of mafic or felsic affinity. A number of studies have demonstrated that these plots can be inaccurate. Furthermore, the traditional approach is limited by the incorrect assumption that silt-sized sediments are refractory and not affected by diagenesis.

A sophisticated separation technique and the combination of optical analysis, RAMAN spectroscopy and quantitative X-Ray power diffraction (Andò et al., 2011) is used to quantitatively determine the composition of silt (heavy and light minerals). This technique has been successfully applied to determine the provenance of Late Jurassic-Cretaceous silt sediments exposed in the Mandawa basin in southern Tanzania. The analysis of light minerals identifies quartz as the dominant phase ($Q_{83-41}K_{25-17}P_{37-0}$). Among feldspars the K-feldspar type dominates on plagioclase and they both increase through time. Heavy mineral concentration (HMC) varies between 0.2% and 2.3% with values increasing from the northern to the southern parts of the basin. Garnet and apatite are the most common minerals together with ultrastable zircon, tourmaline and in minor amounts rutile. Accessory but diagnostic phases are titanite, staurolite, epidote, monazite and glaucophane. Etch pitches on garnet and cockscomb features on staurolite suggest a moderate effect by diagenesis on the pristine heavy mineral assemblage. Multivariate statistical analysis highlights a close association for garnet-apatite, a moderate for titanite-epidote and, not surprisingly, a close one between ultrastable minerals (zircon, tourmaline and rutile, ZTR). The garnet-apatite association is particularly meaningful for samples from the late Jurassic, whereas the strongest ZTR association is found at the Jurassic-Cretaceous boundary. Upper Cretaceous samples are titanite-epidote enriched. All these features indicate significance changes in provenance and/or drainage patterns eroding the Archean/Proterozoic high-grade gneiss/schist in the Late Jurassic, the Paleozoic continental sediments at the Jurassic-Cretaceous boundary and Proterozoic phyllite and schists during the upper Cretaceous.