



Potassium chemostratigraphy - a versatile tool for siliclastic sedimentary archives

Tomas Matys Grygar (1), Karel Mach (2), Michal Hosek (1), Martin Famera (1), Mathieu Martinez (3), and Christian Zeeden (4)

(1) Institute of Inorganic Chemistry AS CR, v.v.i., LEGA, Rez, Czech Republic (grygar@iic.cas.cz), (2) North Bohemian Mines, Bilina, Czech Republic, (3) Géosciences Rennes, Université de Rennes 1, France, (4) IMCCE, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC Univ Paris 06, Univ Lille, 75014 Paris, France

Chemical element analyses are growingly popular in sedimentary research as the potential of XRF data including data from handheld instruments and core. Clay- and silt-dominated sediments in long drill cores and extensive outcrops are nearly routinely analysed for their element composition. The resulting chemical logs often show orbital signatures that allow for palaeoenvironmental interpretations and timescale construction or refinement. However, there is almost a rule that the easier it is to produce some proxy for sediment composition, the more demanding is to understand and interpret these; for sure it is valid for chemical element concentrations and the main mineral constituents. The variations in the concentrations of the most relevant major and minor elements, Al, Si, Fe, Ti, Na, K, Mg, and Ca, are often controlled by chemical maturity (weathering intensity, alkaline and alkaline earth metal ions), provenance (Ti), and grain-size sorting (all elements), and frequently also by post-depositional processes (Fe). It is thus necessary to identify the factors relevant for each particular element dataset and implement these in an interpretation of geochemical compositional data.

We found orbitally controlled variations in concentration of K in the lacustrine sediments of the Most Basin (the Czech Republic, late Miocene). We consider K variations a very versatile proxy for the intensity of continental chemical weathering under humid-warm climates typical for many areas in the mid- to lower latitudes before the Pliocene. Similar attempts can be found in literature, where K or K/Al variations in marine deposits were interpreted as palaeoenvironmental proxies. However, the available papers do not present consistent interpretations. The question is whether K/Al is controlled by chemical weathering, grain-size control, or provenance? A similar example is Ti (or the Ti/Al ratio), which may be interpreted as a provenance marker (mafic volcanism), a grain size proxy, or an indicator of transport mechanism (fluvial, or aeolian). To understand those apparently simple inter-element relationships, we utilised available data on modern fluvial and near-shore marine sediments, either for bulk sediments, or for their grain size fractions. The modern, unconsolidated sediments allow for a direct study of the grain size control of chemical composition, which is not as easy in more consolidated ancient sediments, where acid leaching of their carbonate binders would simultaneously destroy the finest clay minerals. Moreover, in modern sediments, the geography of the source area, geological provenance, and transport routes are known, contrarily to the majority of ancient depositional centres.

The hints to interpret the “simple” element relationships are (1) to respect the grain size effects, e.g. using Al/Si ratio, the most versatile proxy for grain size, (2) to identify the main carriers of Al, K, and Ti that may show specific grain size controls depending on sediment provenance and maturity, (3) to take biogenic components into account, and (4) to analyse profiles (cores) from various parts of the depositional centre to limit the transport effects. We are convinced that if properly treated, relative K concentrations can provide a nearly as universal tool to siliclastic sediments as stable isotopes for carbonate deposits.