



Differences and similarities in the geochemical composition of sedimentary, Dutch Cenozoic formations

Jasper Griffioen (1,2) and Pauline van Gaans (3)

(1) TNO Geological Survey, Utrecht, Netherlands (jasper.griffioen@tno.nl), (2) Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, the Netherlands (j.griffioen@uu.nl), (3) formerly Deltares, Utrecht, the Netherlands

Layered sedimentary formations, as found in the Netherlands, are generally discerned from their surrounding formations by lithostratigraphic, chronostratigraphic or other stratigraphic properties. As such, formations may or may not differ with respect to their geochemical properties. Here, we studied the association of trace elements with major elements and related minerals and the differences therein between Dutch geological formations and some of their members.

Following QC tests, just over 2500 sediment analyses were studied from about 130 drillings down to about 30 m that were obtained from a systematic campaign for the western and northern Netherlands and additional data mining for the southern Netherlands. The sediment analyses were grouped into 31 stratigraphic entities, where seven of them are subsets at the geological member level. The size of the individual datasets varies from 40-50 samples to close to 400. Twenty datasets were dominated by sand samples; five were dominated by clay samples and the rest was lithologically heterogeneous. Classical factor analysis (FA) was applied to allow comparison with earlier applications of FA on small datasets from parts of the Netherlands. The variables comprise the major elements except Si and the trace elements As, Ba, Cr, Ni, Pb, Sr. The datasets from the systematic national campaign also contain clay, silt and organic matter contents. Nb, Rb, Th, U, V, Y, Zr were included for datasets from the southern Netherlands, and more incidentally Cu and Ti. Here, rule of thumb that the number of samples should exceed the number of variables by a factor of at least 2 was always fulfilled. Factor analysis was performed on logtransformed data.

The optimum number of factors was on average 3.13. The total explained variance varies between 0.66-0.92 and was lowest for the 2-factor models. For the latter, choosing models with more factors did not result into a much better description of the geochemical variability. Mostly, the most prominent factor is an Al-factor and a Ca-carbonate factor is secondary. In some 2-factor models, these are combined into one. This seems to reflect a signal of detrital minerals other than quartz. The Ca-factor is frequently co-defined by Sr and Mn, and by Fe, Mg, P and As in about one third of the cases. Detrital Ca-carbonate, preservation of dolomite during weathering and secondary precipitation of siderite and vivianite seem to determine the variability of this factor. A Na-feldspar factor (sometimes combined to a Ca-carbonate/Na factor) is repeatedly present when the dataset comprises both clay and sand samples, indicating independence of Na content on grain size distribution as well as Al content. A S-factor appears in half of the FA-models that often contains As and organic matter reflecting redox diagenesis; other trace elements are seldom present indicating they are not prominent as impurities in pyrite. When included, non-reactive trace elements may be reflected in a heavy minerals factor. Our broad investigation confirms earlier findings for Dutch soils and individual Cenozoic formations, while a strong discrepancy is found with FA-models for suspended matter in the Rhine-Meuse-Scheldt delta system.