Sequential factor analysis as an alternative approach to standard factor analysis

P.J. VAN HELVOORT AND P.F.M. VAN GAANS

Centre for Geo-ecological Research, Department of Physical Geography, Utrecht University, P.O. Box 80115, 3508TC Utrecht, the Netherlands p.vanhelvoort@geog.uu.nl

The application of multi-variate methods, like the widely used Factor Analysis (FA), is often complicated by non-normality or extreme values, which are common features of geochemical or hydrochemical data sets. Apart from heterogeneity in these data sets, the results of R-mode factor analysis also depend heavily on the number of factors extracted and the set of variables entered.

Sequential Factor Analysis (seqFA) is proposed as an alternative approach to FA, and deals with these problems in a structured, four-step procedure. The factor model is developed gradually, by carefully evaluating the effects of outliers, the optimum number of factors that should be selected for rotation, and the most informative set of variables. The criteria in each step of seqFA are flexible and subjective to some degree, but thereby allow the researcher to develop a multi-variate model that optimally suits his research goals with a given data set. Other advantages of the seqFA approach are: efficient data use, more pronounced factors that are better interpretable, and the identification of a limited number of "key variables", which host most of the variability in the data set.

Sequential FA was designed for a heterogeneous data set of 145 sediment samples and also tested on a second data set of 226 water samples. In both cases, seqFA successfully identified the processes and the key variables responsible for a large part of the variability in the data sets. The FA models were very stable after removal of only a small number of outliers. The results endorse that seqFA is data efficient, and optimizes the results of FA for geochemical and hydrochemical data sets.

Geological setting and biogenicity of 3.45 Ga stromatolitic cherts, East Pilbara, Australia

M.J. VAN KRANENDONK[1], G.E. WEBB[2], B. KAMBER[3], AND F. PIRAJNO[1]

[1]Geol. Survey W. Australia, E. Perth, WA, 6004, Australia (martin.vankranendonk@doir.wa.gov.au)

[2].School Natural Resource Sci., Queensland Uni. Technology Brisbane, Qld., 4001, Australia (ge.webb@qut.edu.au)

[3]ACQUIRE, Uni. Queensland, St. Lucia, Qld, 4072, Australia (kamber@earthsciences.uq.edu.au)

Geologic data indicate that host metabasalts to 3.45 Ga stromatolitic chert horizons in the east Pilbara (EP) were erupted on a substrate of older continental crust to 3724 Ma, forming an oceanic plateau, analogous with Kerguelen plateau. The EP plateau was constructed in two periods: 3530-3426 Ma and 3350-3310 Ma, separated by deformation and an erosional unconformity. Cherts in the lower succession are associated with swarms of underlying hydrothermal chert+/-barite veins and zones of advanced argillic, phyllic, and propylitic footwall alteration. This, together with phreatomagmatic breccia textures in some veins, presence of hydrothermal kaolinite, and other field data indicates chert precipitation as chemical sediment in distal parts of active epithermal systems, thereby precluding an origin of the veins as Neptunian dykes. Controversial microfossils and putative stromatolites are directly associated with hydrothermal veins and locally occur in the subsurface, suggesting chemoautotrophy of component microbes.

The c. 3400 Ma Strelley Pool Chert at the base of the upper succession contains stromatolites in three lithofacies: conical, locally branching stromatolites in laminated carbonate that are locally distributed in onlapping biostromes; columnar stromatolites in ferruginous mudstones; degraded microbial mats in sandstone. Cross cutting, zoned black-white hydrothermal chert veins and associated footwall alteration (including alunite) in this case are interpreted as secondary, related to eruption of overlying high-Mg basalt. Peloidal textures, edgewise conglomerates and desiccation cracks in the carbonate indicate deposition as sediment in shallow water to peritidal conditions affected by currents, precluding deposition as rigid cement crusts. REE data confirm that they are primary chemical precipitates from reducing seawater. Carbonate recrystallization and replacement by chert is interpreted to have obliterated fine wrinkly layering in the carbonate stromatolites, with chert preferentially replacing organic-rich layers and inheriting kerogen. Evidence for shallow water supports the interpretation of phototrophic microbes in the development of this, the Earth's oldest, well-preserved carbonate platform.