Can results of multivariate statistical analyses of foraminiferal assemblages serve as a mapping tool? First attempts from the allochtoneous Molasse of Austria

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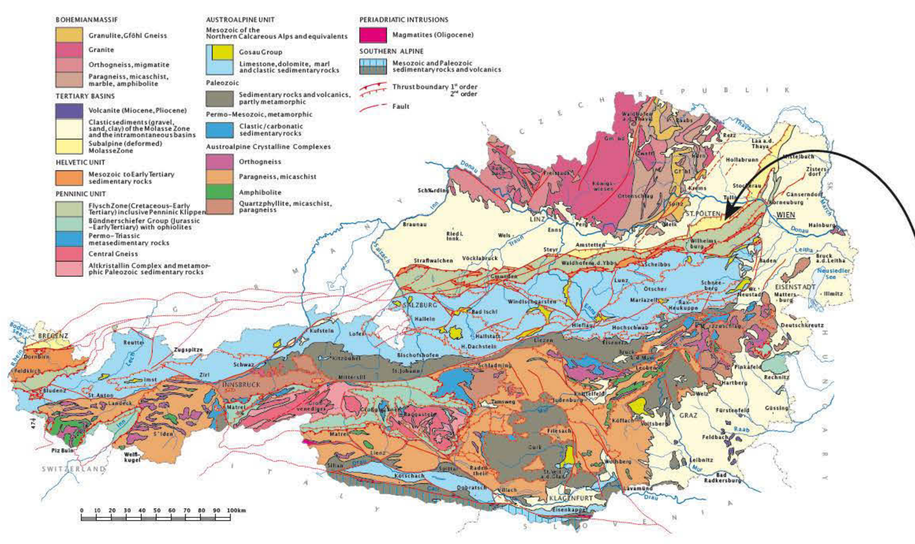


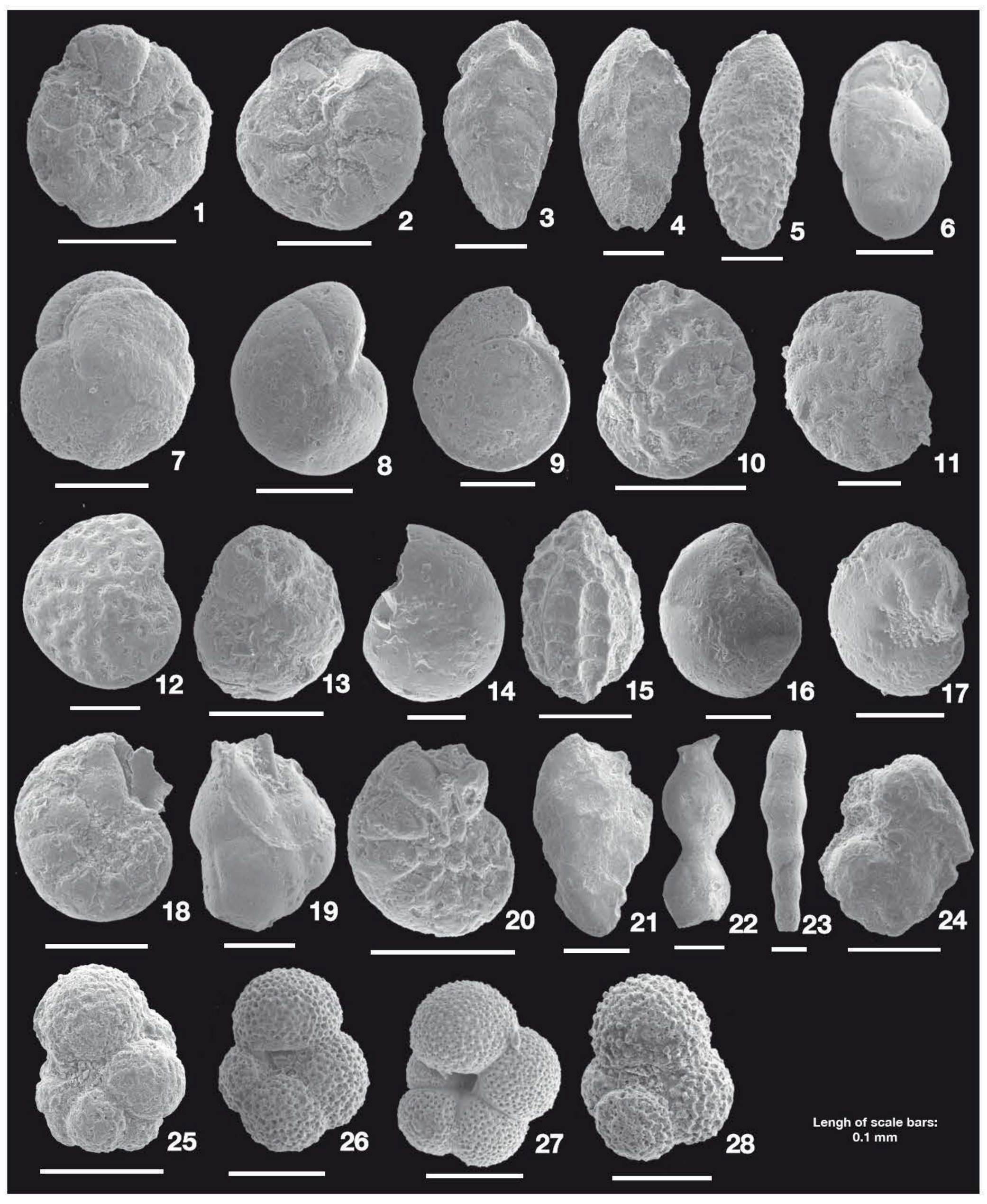
Fig. 1: Geological Map of Austria with working area.

Working area

The so-called *Robulus*-Schlier (Eggenburgian to early Ottnangian), covers large parts of the north-western portion of sheet ÖK57 (Neulengbach) in Niederösterreich west of Vienna (Fig. 1). Its silty marls and clays contain thin sandstone layers of irregular frequency and do not allow subdivisions of the otherwise uniform sediments. Because of low elevation and intensive agricultural activity, only occasional and small outcrops exist and no continuous section was found. Dipping and areal occurrence of the *Robulus*-Schlier suggest thicknesses of several hundred meters. However, fault systems and a synclinal structure indicate intensive tectonic displacement, and real thickness may be less for the relatively short sedimentation interval of c. 3 My. The absence of marker horizons, age indicative foraminifera or other index fossils suggested an eco-stratigraphic approach on benthic foraminiferal assemblages (Fig. 2, 116 species, 51 samples) to subdivide the *Robulus*-Schlier in this area.

Fig. 2: Foraminifera occurring with at least 10% in one sample.

1. *Ammonia pseudobeccarii*
2. *Ammonia viennensis*
3. *Bolivina dilatata*
4. *Bolivina fastigia*
5. *Bolivina plicatella*
6. *Bulimina schischkinskayae*
7. *Cassidulina laevigata*
8,9. *Cibicidoides lopjanicus*
10. *Elphidium orthenburgense*
11. *Elphidium reussi*
12. *Elphidium subtypicum*
13. *Globocassidulina oblonga*
14. *Heterolepa dutemplei*
15. *Lagena sulcata*
16. *Lenticulina inornata*
17. *Nonion commune*
18. *Porosononion granosum*
19. *Praeglobobulimina pupoides*
20. *Protelphidium roemeri*
21. *Semivulvulina* sp.
22. *Stilostomella consobrina*
23. *Stilostomella emaciata*
24. *Textularia gramen*
25. *Cassigerinella globulosa*
26. *Globigerina lentiana*
27. *Globigerina ottnangiensis*
28. *Globigerina praebulloides*



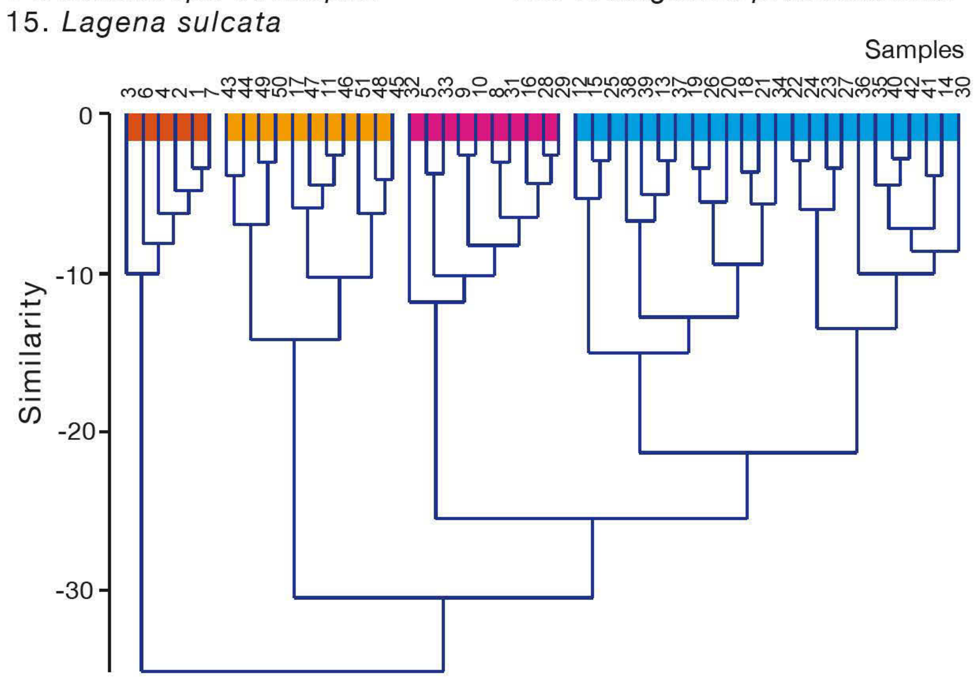


Fig. 3: Dendrogramm of Q-mode Cluster anaysis for benthic foraminifera (Ward's method, log-transfer of percentages).

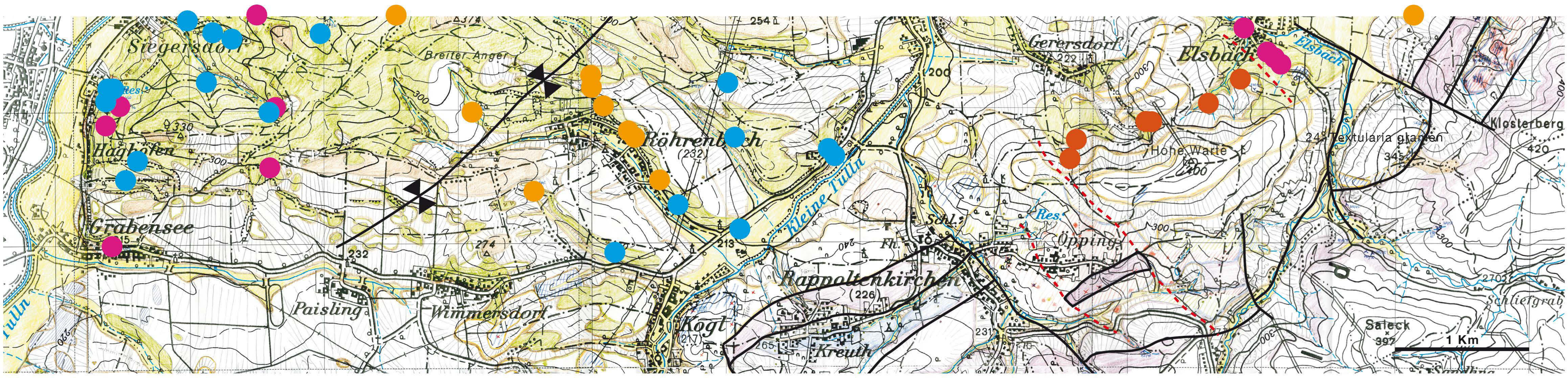


Fig. 4: Geological Map of working area with location of samples used in cluster analysis. See Fig. 3 for color code.

Two multivariate statistical methods were applied: cluster analysis (Figs 3, 4) and canonical correspondence analysis (CCA, Figs 5-7). The method of Ward was used in **cluster analysis** on the partially diverse benthic foraminiferal assemblages (Figs 2.1-24). Planktic foraminifera (Fig. 2.25-28) do not occur in all samples, are much less divers (sometimes monospecific) and are therefore not used here for further analyses. The resulting four clusters (Fig. 3) show different portions of planktic foraminifera (0-87 % planktic foraminifera) and varying assemblage diversities (Fisher α–indices of 1-32). Both proxies are positively correlated and point to different water depths during deposition, ranging from shallow to deep neritic environments. The areal distribution of clusters confirm an assumed synclinal structure and the presence of significant fault systems. They furthermore point to additional fault lines within the Robulus-Schlier (red lines in Figs 4,6). The PAST-package (Hammer et al. 2001) was usedto carry out cluster analysis.

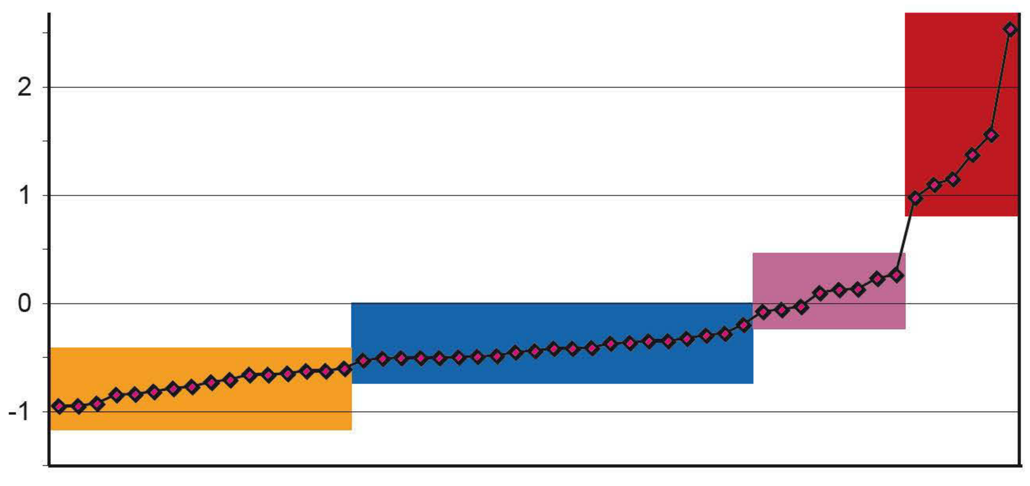


Fig. 5: CCA-Axis 1 sample scores for benthic foraminifera (log-transfer of percentages).

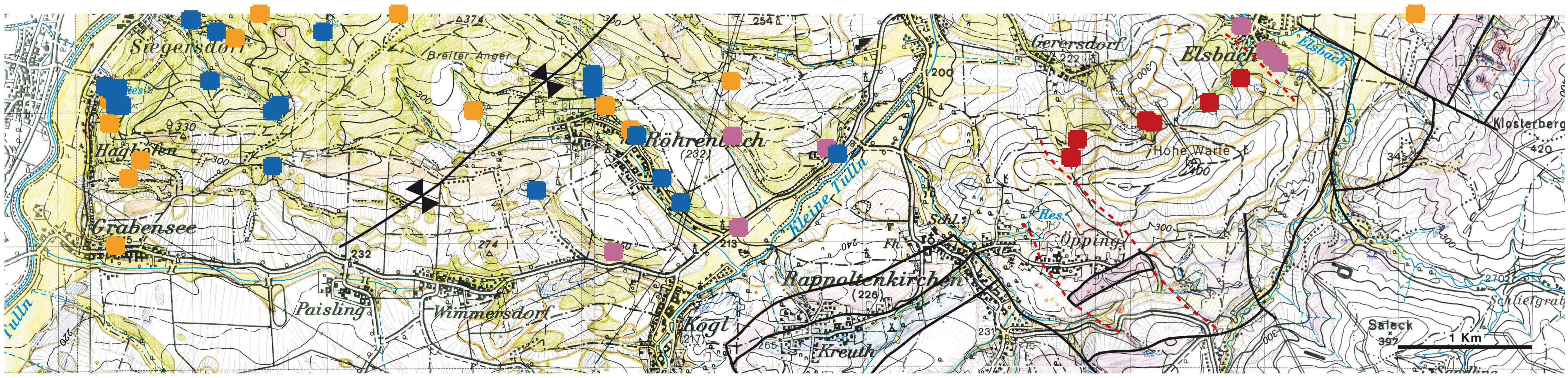


Fig. 6: Geological Map of working area with location of samples used in CCA. See Fig. 5 for color code.

Canonical Correspondence Analysis-sample scores (Fig. 5) show a similar areal distribution for axis 1 values (Fig. 6) as in cluster analysis and also confirm the assumed tectonic structures. Comparison of sample scores with environmental (% planktic foraminifera, Fisher α–index) and areal variables (distance to Flysch formations, distance to an artificial western boundary) indicate a good correlation with depositional depth of the benthic assemblages (Fig. 7), in particular of axis 1 values with diversity (R^2 = 0.57). Apparently, water depth was the most important (known) factor for benthic foraminiferal distribution. The areal distribution of the four groups of axis 1 values furthermore may suggests a SE to NW gradient possibly related towater-depth. The Canoco 4.5 program was used to perform CCA (see Jongman et al. 1995 for further information).

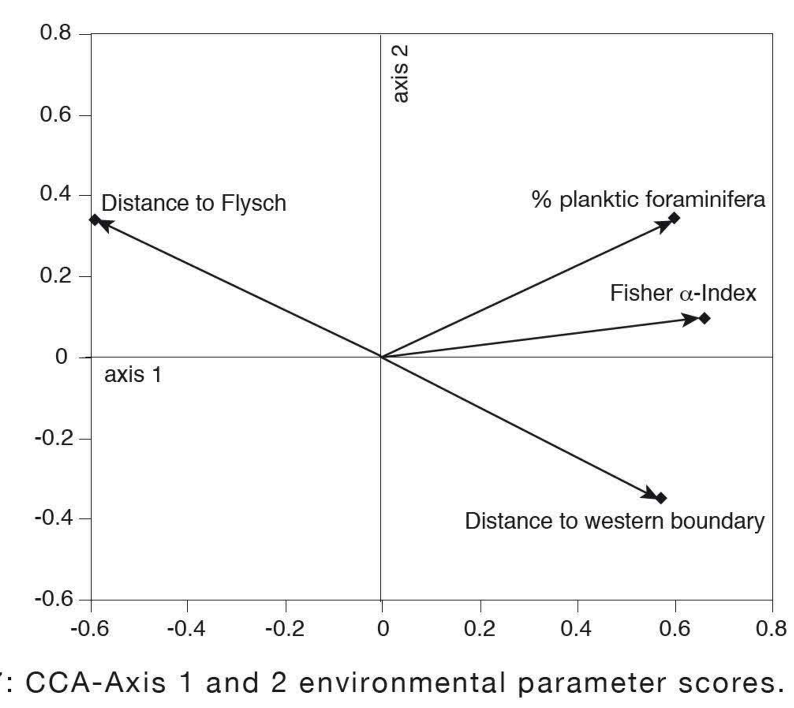


Fig. 7: CCA-Axis 1 and 2 environmental parameter scores.

Hammer, O., Harper, D.A.T. and Ryan, P.D., 2001. Palaeontologia Electronica, 4(1): 9pp. http://palaeo-electronica.org/2001_1/past/issue1_01.htm.
Jongman, R.H.G., Ter Braak, C.J.F. and Van Tongeren, O.F.R.E., 1995. Data analysis in community and landscape ecology. Cambridge University Press, 299 pp.