Holocene Paleoclimatic interpretations from shallow sediment cores from a freshwater lake in eastern Antarctica

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Lake Priyadarshini is one of the largest lakes in the Schirmacher Range, a group of low-lying hills of 50-200 m height, of eastern Antarctica. With a total area of 0.75 km^2, Lake Priyadarshini is closest to the Indian Station, Maitri. The shallow sediment cores from Lake Priyadarshini are characterized by the dominance of silty clay fractions throughout indicating more or less uniform sediment supply, mostly through settling of suspended load. Mineralogically, detrital quartz and feldsparrepresent the principal allogenic phases, along with illite, chlorite with minor amount of mixed-layered minerals. Absence of typical clay minerals reflects periglacial environment of the Antarctic region with a short summer period and limited moisture supply, which has not encouraged chemical weathering processes.

The elemental concentration of Fe, Mn, Pb, Cd, Cu, and Zn in the allogenic fraction of core sediments seems to reflect the post-depositional processes including those initiated by microorganisms or bacteria viz. oxidation, reduction, or substitution with methyl groups. The cyclic profiles of these elements shows some correlation with organic matter content, as most of these metals are probably bound with organic matter forming organo-metallic complexes. Radio-isotope measurements on sediment cores using the high resolution gamma ray spectrometer show ^{137}Cs activity only in the top most section and the rapid decrease with depth appears to indicate a very low sedimentation rate. ^{210}Pb profile seems to be highly correlated with the ^{226}Ra activity and it seems to indicate migration of ^{210}Pb produced in-situ from the decay of earlier deposited ^{226}Ra through anaerobic bacterial reductions to methyl derivatives. The radiocarbon age of the sediment sample (20-50 cm) from Priyadarshini lake was calculated on ^{14}C measurement as 7190±300 years B.P. Based on ^{137}Cs and ^{14}C, the rate of sedimentation in the lake works out to be 0.05 to 0.35 mm/yr, which is consistent with the sedimentological studies.

Inferences about climatic changes have been made based on elemental distribution, ^{14}C date and data from pollen distribution. The variation of redox conditions of the lake basin can be inferred from the distribution of Fe and Mn concentrations. At a core depth of 35-40 cm corresponding to a radiocarbon age of around 7kyr, low concentrations of Fe and Mn indicate reducing conditions. The pollen data also indicate a shallow lake condition during this period (Phase I) characterized by scanty terrestrial vegetation constituted of grasses together with scattered distributed elements of *Chenopodiaceae/Amaranthaceae*, moderate frequency of *Cosmarium*-a fresh-water alga, coupled with preponderance of *Arcitarch* – a shallow fresh/marine water dweller. This phase is followed by an oxidising phase (Phase – II) marked by increase in elemental concentrations of Fe, Mn, Cu and Zn. A climatic change is also indicated by vegetational composition during this period characterized by very significant improvement of grass vegetation, increased frequencies of *Cosmarium* and simultaneous decline in *Acritarch*. All these evidences point to inception of warm climate and a wider expanse of lake in consequence of retreat of ice. This phase is followed by a sharp decline in grasses and disappearence of most of the herbaceous elements and this change is also marked in the decrease of elemental concentrations (Phase III). The near-surface increase in elemental concentration marks the amelioration of climate during recent times and corresponds very well with the improvement in *Cosmarium*.

Zircon in the Val Gardena sandstone from the Ziri region, W Slovenia

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In Slovenia, the largest continuous belt of clastic rocks of the Val Gardena Formation of Permian age extends in the Ziri region, between Cerkno and Smrecje belonging to the Idrija - Ziri Overthrust structure.

The Val Gardena Formation has drawn attention of many geologists with the occurrences of uranium and copper in ore concentrations. MLAKAR (1979 – 1983, 1985) geologically mapped the Ziri region and subdivided the Val Gardena Formation into six members: Brebovnica Member, Hobovše Member, Koprivnik Member, Zala Member, Škofje Member, Doberca Member. The thickness of the Val Gardena Formation locally varies between 200 and 1750 m and reaches its maximum in the region of Zirovski vrh. The Val Gardena Formation is underlain by dark grey mostly shaly clastic rocks of attributed Carboniferous age. The upper part of these beds might be of Lower Permian age. The overlying beds consist of the Upper Permian carbonate rocks.

Geologists dealing with the Val Gardena Formation, especially in the lower uranium bearing part (Brebovnica Member), had difficulties with detailed correlation. With little success we tried to improve the lithofacial correlation using the mineral composition of light and heavy fraction. Finally, zircon was chosen as a discrimination mineral. It was one of the most frequent components in the relatively quickly changeable suite of heavy minerals and was present in all samples. The form of zircon is relatively easy to observe, determine, and quantify, but it depends on numerous physical and chemical conditions, which are influenced by crystallisation conditions.

In the Val Gardena sandstone the zircon grains are euhedral and rounded. The examined euhedral grains of zircon were classified into 37 typological forms from the middle and lower part of the Pupin's typological classification (PUPIN 1980), which comprises 64 different forms. Beside more or less symmetrical zircon grains also grains with two typological forms and complex intergrowths were found.

Chemical composition data for different typological forms collected so far do not allow a reliable conclusion on the relation between the chemical composition of zircon and its crystal forms. Nevertheless, some differences in the content of Hf, Y, Th, U, and Fe substituting Zr in the crystal structure between different types of zircon were detected.

For further quantitative evaluation only the typological forms (S7, S8, S9, P2, S12, S13, S14, S17, S18 S19, S20, P4, S22, S23, S24) having the relative frequencies exceeding 1.5 % of the entire zircon form population were considered. The correlation among different types of zircon was relatively low. Somewhat higher correlation between the typological forms was within seven determined clusters.

Clusters of cases (samples) defined by the relative frequencies of the typological forms of zircon show, on the basis of the available data, that there is no possibility for more detailed and confident correlation within the members of the Val Gardena Formation. However, the members of the Val Gardena Formation are statistically different on the level $p < 0.05$. The typological forms S8, S23, P4, P2, S22, S18, S7, S19 and S14 make the most significant contribution to their discrimination. The lithostratigraphic members can be discriminated and correlated with the mean certainty of 82 %.

Finally, we tried to interpret types of igneous rocks in the source area according to the relative frequencies of the crystal forms of zircon population in the Val Gardena sandstone. The most frequent zircon types S19, S24, and interpretation data from PUPIN (1980, 1985) indicate the prevailing influence of orogenic type igneous