Geophysical Research Abstracts
Vol. 13, EGU2011-10980, 2011
EGU General Assembly 2011


# The Trogkofel Limestone (Lower Permian, Carnic Alps): a shallowing-upward succession of a carbonate platform margin

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In the area of the Trogkofel massif (Carnic Alps, Austria/Italy), during the Early Permian, a succession 400 m in preserved thickness accumulated along a grainstone-dominated platform margin. The succession consists mainly of shallow-water bioclastic limestones intercalated with reefal mounds and limestones with stromatactoid fabric.

The Trogkofel Limestone sharply overlies a well-bedded package of shallow neritic limestones with algal mounds (Zweikofel Formation). The vertical change from the Zweikofel Formation to the Trogkofel Limestone records a distinct deepening associated with a backstep of the shelf margin. Up-section, the lower part of the Trogkofel succession is characterized by mounds of bryozoan-Tubiphytes (Shamovella) boundstones, intercalated with intervals of bioclastic grain- to packstones; in addition, phylloid-algal limestones associated with grey- to red-coloured bioclastic packstones rich in crinoid fragments are present. The upper part of the Trogkofel section is dominated by shallow-water bioclastic grainstones, intercalated with intervals up to a few meters thick of laminated Girvanella boundstones. Pervasive dolomitization of the topmost part of the Trogkofel Limestone, as well as localized dolomitization deeper down-section, commonly obliterated primary depositional fabrics. The succession of the Trogkofel Limestone is interpreted to record shallowing upward.

The main microfacies types in the group of 'mound facies' of the Trogkofel Limestone are:
a) bioclastic grain- to packstone, locally rudstone, of Tubiphytes, bryozoans, echinoderms, phylloid algae and a varying amount of other calcareous algae; micropeloidal matrix is scarce;
b) several types of boundstone: the most common type of boundstone consists of Tubiphytes, bryozoans, phylloid algae and a higher content of agglutinated worm tubes and small sponges in the lowermost part of the section; patches of micropeloidal wacke- to packstones are associated with these boundstones; Tubiphytes-Pseudovermiporella boundstones build firmgrounds, which are overlain by bioclastic grainstones or oncolithic rudstones/grainstones.
c) cementstones with a framework of phylloid algae; geopetally infilled bioclastic wackestone may be deposited upon the algal thalli. Prior to the precipitation of botryoids or cement crusts (calcified aragonite) the algal thalli are often encrusted by Archaeolithoporella and/or Tubiphytes. Cementstones also occur in large framework pores of boundstones. Another type of cementstone was formed by diagenetic processes in dissolution cavities, where thick fringes of isopachous radiaxial fibrous calcite and calcite spar were precipitated.
Common facies types in the grainstone facies of the Trogkofel Limestone are: a) bioclastic grainstone, locally rudstone, which consists of phylloid algae, calcareous green algae, sponges, fusulinids, echinoderm fragments, bryozoans, benthic foraminifera;
b) laminated Girvanella boundstones with few interspersed benthic foraminifera and calcareous green algae; pockets in the boundstone are filled with bioclastic rudstone/grainstone often with oncolithic encrustation.

The mound facies is riddled by cavities up to half a meter in width that commonly are coated by crusts to hemispheroids to digitate growth forms of Archaeolithoporella, and filled by botryoidal fibrous cements and internal sediments. The cavities probably represent an original firmground burrow network, modified and widened by internal erosion and/or syndepositional tectonism. In many cavities, growth of Archaeolithoporella crusts changed repeatedly with precipitation of layers of botryoidal fibrous cement. Towards the centre of cavities an overall decrease in thickness of Archaeolithoporella crusts is observed.