



Ultrahelvetic units in Austria – pieces of a puzzle from the Cretaceous European continental margin

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The Helvetic Zone comprises sedimentary strata deposited on the shelf and upper slope of the European plate in a passive margin setting during the Cretaceous. Shelf deposits of the Helvetic realm are exposed mainly in thrust complexes in the western part of the Eastern Alps (Vorarlberg). The Ultrahelvetic units comprise deeper-water strata originally situated to the south of the Helvetic realm, at the continental slope of the European Plate into the Penninic Ocean (“Alpine Tethys”). In eastern Austria the Gresten Klippen Zone is considered as part of the Ultrahelvetic realm. The Lower Cretaceous deposits of the Austrian Ultrahelvetic units and the Gresten Klippen Zone are characterized by a pelagic limestone facies, overlain by a variegated marlstone/shale succession (“Buntmergelserie”) from the Albian on. In the Paleogene parts of the “Buntmergelserie” huge olistoliths are common pointing to increasing Alpine tectonism during this time.

The palaeogeographically northernmost Helvetic unit in Vorarlberg (western Austria) comprises micritic globotruncanid limestones of Upper Cretaceous age. Within these outer shelf grey limestones of the Seewen Formation thin reddish intercalations are present in the Turonian and Santonian. Further downslope, in the Ultrahelvetic realm (Liebenstein Nappe, Vorarlberg) red intervals increase in number and thickness and are present both in the pelagic Liebenstein limestone (Turonian-Santonian) and the marly Leimern Formation (mainly Campanian).

Ultrahelvetic units were investigated in Bavaria, Salzburg, Upper Austria and Lower Austria. They occur as tectonic slices and tectonic windows within the Rhenodanubian Flysch Zone. Mid- and Upper Cretaceous Ultrahelvetic rocks in Upper Austria (Rehkogelgraben, Buchberg) are characterized by pelagic marl-limestone cycles. Al-

bian dark grey marls and marly limestones are overlain by Cenomanian light grey, spotty limestones and medium grey marls. Calcispheres and planktic foraminifera are abundant. A black shale interval can be correlated with the Late Cenomanian OAE2. TOC values are about 5 %. Rock Eval analysis indicates the predominance of marine organic matter. The Lower Turonian is characterized by a 2 m succession of white to light grey marly limestones with missing or thin marl intercalations. Marly limestones have high percentages of planktic foraminifera. Carbonate contents vary between 65 and 92 %. Above, the thickness of marl intercalations increases again and first red to brownish colours are found within the marls. Higher up the section also the limestone intercalations display a red to pinkish colour and the section continues into the Coniacian and Santonian. Limestones are rich in planktic foraminifera. Some fragmented inoceramus shells are also present. Red colours predominate up to the Lower Campanian, then a lower to upper Campanian succession of grey, sometimes fossiliferous marls follows, overlain by dark grey to black, silty and sandy marls of Maastrichtian to Paleocene age.

Cretaceous strata of the Gresten Klippen Zone in Lower Austria indicate increasing water depths around or below the local calcite compensation depth. Grey and red marlstones and claystones of Albian to Eocene age of the Gresten Klippen Zone are mainly carbonate-poor to carbonate-free marls and shales rich in “flysch-type” agglutinating foraminifera and comprise only minor amounts of planktonics. Consequently a northern, (shallower, e.g. Rehkogelgraben) and a southern (deeper) Ultrahelvetic facies (Gresten Klippen Zone) can be distinguished. These lower bathyal deposits probably interfinger with thin bedded turbidites and variegated shales of the Rhenodanubian Flysch Zone.

These Helvetic/Ultrahelvetic units define a paleodepth transect of the Late Cretaceous European continental margin into the Alpine Tethys, from the shelf deposits of the Helvetic units to the bathyal to abyssal Ultrahelvetic Buntmergelserie. Red oceanic deposits are present in the outer shelf successions and predominate the slope deposits. Facies transitions into the Rhenodanubian Flysch indicate a close paleogeographic connection between these Helvetic units and the Penninic flysch.