



Latest news on the MORB within the Arosa-Zone

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Convergence of the African and European Plates during the Cretaceous and Paleogene was accompanied by subduction of crust of the Piémontaise (Penninic) ocean underneath the Apulian Plate. However, non-subducted slices of this oceanic crust are today exposed along the alpine suture zone from southern Italy along the northern Apennine and western Alps as far north as southern Germany. Its northernmost extension is known as Arosa-Zone and is exposed as a 10m to some 100m wide seam along the northwestern base of the Austroalpine Nappes from the Upper Engadin in the south through the Rätikon in Switzerland, Austria and Liechtenstein as well as the Walsertal in Austria into the Allgaeu in SW Bavaria.

Aside from fragments of the austroalpine nappes, tectonic slices of the **Piémontaise oceanic crust** and ultramafic fragments (serpentinites, ophicalcites) of the late Paleozoic **subcontinental lithospheric mantle** occur within the Arosa-Zone, both often with their original sediment coverage of Upper Jurassic radiolarites and/or Lower Cretaceous Aptychen limestone [DESMURS et al. 2001, BILL et al. 2001, BERNOULLI et al. 2003, MANATSCHAL 2004]. However, fragments of the Piémontaise **suboceanic mantle** have not been identified yet.

The basalts occur as pillowed ol-plag-phyric tholeiitic magmas with a strong hydrothermal ocean floor alteration, only clinopyroxenes and spinell phases being preserved in primary composition. While exhibiting alpine metamorphic overprint under eclogite facies conditions in the Western Alps only sub-greenschist facies (very low-grade) conditions were reached in the Arosa-Zone. The transition to greenschist (low-grade) overprint is indicated south of Arosa by the paragenesis of epidote and pumpellyite as well as loss of hydrothermal $\delta^{18}\text{O}$ -ocean floor signals [FERREIRO

MÄHLMANN 2001, WEISSERT & BERNOULLI 1984].

The basalts can be distinguished by their REE patterns (N-MORB and T-MORB), only the depleted of which are known to occur in the northern half of the Arosa-Zone, the Walsertal-Zone (Liechtenstein to Allgaeu). Both types also occur in the southern extension of the Arosa-Zone, the Platta Nappe, where the T-MORB are associated with the Upper Serpentinite Tectonic Unit and the N-MORB with the Lower Serpentinite Tectonic Unit [DESMURS et al. 2001]. For the latter an U/Pb age of 160 Ma was determined for zircon in a gabbro [SCHALTEGGER et al. 2002]. While the suboceanic asthenospheric mantle is isotopically indicated as source of the N-MORB, the subcontinental lithospheric mantle is assumed for the T-MORB for lack of data [BILL et al. 2000, SCHALTEGGER et al. 2002].

New observations are that the **N-MORB** in the Walsertal-Zone as well as in the Lower Nappe Unit at Arosa occur as sediment-free “pillow supported” successions that are either covered by reddish pelites (radiolarites) of Late Jurassic age or reddish to grey limestones in Aptychen-facies of Lower Cretaceous age. This indicates that the emplacement of N-MORB may be asynchronous. On the contrary, the **T-MORB** pillow sequences in the Upper Tectonic Unit at Arosa as well as in the eastern Rätikon and the Engadin window exhibit matrix supported emplacement patterns with spherulitic skins as thick as 4cm as well as peperitic textures of magma spheres and lumps embedded in greenish-grey pelites. These textures are not bubble fillings, as widely assumed except by [HEUGEL 1982], but rather unequivocal prove for the effusive emplacement into wet sediments. The low degree of brecciation of the sediments as well as the low vesicularity of the pillows may be indications for a mid-bathyal to bathyal depth of effusion.

The lithological and chemical differences being accompanied suggests that the N-MORB erupted in a (distal ?) oceanic environment free from sediments while the T-MORB erupted in a sediment dominated environment possibly closer to the continent. Whether the emplacement occurred synchronously or these differences possibly indicate sequential stages during development of the Piémontaise ocean, as suggested by our cooperation partners [MANATSCHAL et al. 2003], is still matter of our ongoing discussions.