TIMING OF FORMATION AND SUBDUCTION OF THE ZERMATT-SAAS OPHIOLITES (WESTERN ALPS): A COMBINED CATHODOLUMINESCENCE – SHRIMP STUDY USING ZIRCON

RUBATTO, D. & GEBAUER, D.

Department of Earth Sciences, ETH, Sonneggstrasse 5, CH-8092 Zürich, Switzerland.

Although of fundamental importance for the understanding of the geodynamic evolution of the Alps, the timing of formation and metamorphism of the Alpine ophiolites is still poorly constrained. In order to test our hypothesis on Tertiary subduction events in the Pennine realm of the Central and Western Alps, zircons were separated from the following rocks of the Zermatt-Saas ophiolites: high-pressure (HP) metagabbros from Allalin and Täschalp as well as ultra-high-pressure (UHP) eclogites and deep-sea sediments from the area of Lago di Cignana.

An omphacite-garnet bearing olivin-gabbro, collected from a block of the Allalin glacier, gave an age of 165.5 ± 3.0 Ma (95%c.l.). The zircons (U: 200–900 ppm) show oscillatory zoning and Th/U ratios (0.2–2.0) typical for magmatic rocks. The 165 Ma old zircons do not have any inherited cores, however the sample contains some inherited zircon grains. Interestingly, in a second metagabbro exclusively inherited Proterozoic and Archean grains were present. Thus, the existence of inherited zircons in these two gabbros and in other samples from Täsch Valley can be taken as an argument for the presence of continental crust at an early stage of oceanization, i.e. these gabbros would not have formed in a typical MORB-environment in the middle of a large ocean. At Täschalp (Mellichen), two cumulitic leucogabbros in eclogite facies yield the same age in the oscillatory zoned zircon domains, i.e. 162.9 ± 1.8 Ma.

The upper Middle Jurassic ages of these gabbros are the most reliable and precise ages obtained for the formation of any Alpine ophiolite so far. They are in agreement with an Ar-Ar phlogopite age (160 ± 8 Ma) obtained from two pyroxenites within the Totalp serpentinite (Arosa Zone; PETERS ET AL., 1987) and with the age of Corsican ophiolitic albitites dated conventionally by the multi-grain zircon technique (161 ± 3 Ma, OHNENSTETTER ET AL., 1981). Indications for a Jurassic opening of the Tethys are also coming from zircon fission track data from the Northern Apennine (BIGAZZI ET AL., 1972). On the other hand, zircon and apatite fission track data for the Piemontese Zone (CARPENA & CABY, 1984) as well as K–Ar ages of ophiolites from the Flysch de Gets (BERTRAND & DELALOYE, 1976) give inconsistent older ages.

Within the Zermatt-Saas zone nearly all rocks show evidence of Alpine blueschist and/or eclogite metamorphism. According to geothermobarometric data this portion of oceanic crust was subducted to temperature of ca. 600°C and pressure of 17–20 Kb in the area of Täschalp (BARNICOAT & FRY, 1986) and 26–28 Kb at Lago di Cignana where coesite has been described (REINECKE, 1991).

In this last locality, the age of the P-T-peak could be dated for eclogites and UHP deep-sea sediments. Both metamorphic and metamorphically reset crystal domains gave ages averaging 44.2 ± 1.4 Ma. The youngest inherited zircon core of a garnet-phengite-quartz-schist yielded a concordant age of 161 ± 7 Ma (3 data points) arguing for a Middle to Late Jurassic maximum sedimentation age of these deep-sea sediments. This age is also supported by biostratigraphic arguments that constrain the deposition of radiolarites to the Middle to Late Jurassic (e.g. BAUMGARTENER, 1987). The only known magmatic rocks of this age that could have supplied the detritus are the gabbros discussed above. Thus, in tune with the occurrence of inherited pre-gabbroic zircons of probably continental sources, these gabbros may have been emplaced into thinned continental crust and recycled into the just formed deep-sea environment.

The Middle Eocene metamorphic age is in line with a Rb/Sr phengite age of 44.6 ± 1 Ma (BARNICOAT et al., 1995) and with a Sm–Nd age of 52 ± 18 Ma (BOWTELL et al., 1994) obtained from an eclogitic metabasalt of the Täsch Valley. An Eocene age is also known from the Monviso ophiolite: Ar–Ar studies on 3 phengite from HP metagabbros gave plateau age between 48.6 ± 2.7 Ma and 51.4 ± 1.2 Ma. (MONIE & PHILLIPOT P., 1989). The slight age difference between the Zermatt-Saas unit and the Monviso unit could be ascribed to a real difference in subduction ages or to the presence of excess Ar, widely demonstrated to exist in HP-metamorphic terrains (e.g. KELLEY et al., 1994).

The data presented here favour a tectonic evolution of the Alps that conforms with recent geochronological studies and that contradicts the long standing hypothesis of a Cretaceous subduction within the Western and Central Alps. The first domain to be subducted in the Eastern Alps, was the Austroalpine domain where Permian gabbros at Kor- and Saualpe underwent eclogite-facies conditions in Mid-Cretaceous times (THÖNI & JAGOUTZ 1992 and GEBAUER & PAQUETTE unpubl. data). In the Western and Central Alps closure of oceanic basins and subduction of continental crust developed later. The continental crust of the Sesia Zone, probably of micro-continental origin, was subducted first, i.e. in the very Early Palaeocene (64.9 ± 1.2 Ma, RUBATTO et al., 1995). Then, going further N or NW, subduction started to consume the oceanic crust of the Piemontese-Ligurian basin that, as demonstrated here for the Zermatt-Saas ophiolites, reached the P–T peak in the Middle Eocene. After closure of this ocean, continental crust was subducted below the Adriatic margin and reached its P–T peak in the Late Eocene, around 35 Ma. Parts of the Dora Maira, the Monte Rosa and Adula-Cima Lunga nappe contain relics of this last subduction stage (GEBAUER, 1996 and RUBATTO & GEBAUER, unpubl. data).

The timing summed up above requires a partial revision of the traditional paleogeographical and geodynamic reconstruction of the Alps. As proposed by FROITZHEIM et al. (1996) the evolution of the Alpine area in Mesozoic and Tertiary times is controlled by the existence of distinct basins and continental blocks which close and underwent HP-conditions at different times. Thus, as has been proposed for the European Hercynides since 1982 (GEBAUER & GRÜNENFELDER, 1982), also the Alps show a series of subduction events that can best be explained with the successive docking of microcontinents of Gondwana derivation.

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