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Evidences of an Ordovician magmatic cycle in the Ossola-Ticino basement (Central Alps, Italy)

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The Lower Penninic basement units of the Ossola-Ticino tectonic window (Central Alps, Italy) are mainly derived from Late-Variscan (Late Carboniferous to Early Permian) granitoids, minor metapelites with small marble and amphibolite layers (generally interpreted as the host rocks to granitoids), and meta-serpentinites (tectonically interleaved before the Alpine cycle). The pre-Mesozoic basement units are separated by "synclines" mainly filled with Mesozoic meta-sediments (mainly calcschists). This tectonic multilayer was deformed and metamorphosed during the Alpine orogenic cycle.

In this contribution we present new field, petrographic, geochemical and geochronological data that demonstrate the existence of a second cycle of pre-alpine magmatism, at about 450 Ma (Ordovician), predating the "classical" late-variscan granitoids and having a distinct geochemical signature. These rocks have been mapped in the Monte Leone Nappe, a few kilometres to the N of Domodossola, in the Crevoladossola area, but are likely to occur also in other areas and in other Alpine nappes of the Ossola-Ticino window. Characterising these rocks in the field is difficult due to the superposition of Alpine polyphase deformations and metamorphism. Anyway, even in the Crevoladossola area, corresponding to the Alpine high-strain Southern Steep Belt, the Ordovician metagranitoids can be distinguished from the Late-Variscan ones by means of a careful structural and petrographic mapping. Ordovician metagranitoids are generally leucocratic, composed by Qtz+Pl+Kfs±WM±Bt±Ep, whereas Late-Variscan ones are mesocratic, fine grained, and mainly consist of Qtz+Pl+Kfs+Bt±WM±Ep±Ttn.

The Ordovician metagranitoids show silica contents ranging from 62 to 77 wt%, and are generally metaluminous or weakly peraluminous with A/CNK ratio close to 1 (0.9-1.1) and A/NK ratio between 1 and 2. All samples follow a typical AFM calcalkaline trend and plot in the high-K calcalkaline field. They are enriched in K_2O, TiO_2 Rb, Ba, and Zr and depleted in Al_2O_3, Fe_2O_3t, CaO, Na_2O, P_2O_5 and Sr with respect to the Late-Variscan metagranitoids. Their REE pattern is characterized by LREE enrichment (100-300X) with respect to HREE (6-20X; $(La/Yb)_N$=5.5-12.6) and negative Eu anomaly (Eu/Eu*=0.46-0.72). Instead, Late-Variscan metagranitoids show a flatter pattern because of their HREE-enrichment with $(La/Yb)_N$ ratio between 3.9 and 10.6, and a more pronounced Eu anomaly (Eu/Eu*=0.2-0.4). In the multi-element spider diagrams normalized to primitive mantle, the Ordovician metagranitoids are enriched in LILE (Cs, Rb, Ba, Th, U, K), but they show very pronounced negative P, Ba, Nb and positive Pb and Zr spikes. The Late Variscan metagranitoids also show enrichment in LILE, with negative Pb and Ti spikes. In the multi-element spider diagrams, normalized to the weighted average composition of the Late Variscan metagranitoids, the Ordovician samples present negative Ba, P and Sm, and positive Ta, Pb, Ti, Hf, Zr spikes.

A nearly undeformed sample (ML8), representing the most preserved Ordovician metagranitoids, was selected for a SHRIMP II U-Th-Pb geochronological study. All zircons from ML8 sample show typical magmatic textures characterized by a well-defined concentric oscillatory zoning. Some of them are characterized by the presence of inherited cores surrounded by magmatic overgrowths. The age of the inherited cores rages from 563 to 962 Ma, whereas all 13 data points on magmatic rims give a concordant age of 456±4 Ma. According to zircon textures and U-Th geochemistry (U=137-590, Th=24-214, Th/U=0.1-0.4), this age could be interpreted as the emplacement age of the protolith of the Ordovician metagranitoids.

In the area under investigation, Ordovician metagranitoids are always associated to paragneiss and micaschists (with minor amphibolite lenses), which could be interpreted as the pre-Ordovician host rocks. Based on field rela-

tionships, the Ordovician metagranitoids + metapelites could in turn represent the host rocks of the Late Variscan metagranitoids.