The Paleozoic magmatic history of the Maggia and Sambuco nappes, Lower Penninic, Central Lepontine Alps

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Abstract

Magmatic bodies are important markers in paleo-geographic or geodynamic reconstructions of orogenic cycles, even more so in the case of polycyclic events wheremany of the other markers have been overwritten or destroyed. Plutons are relatively easy to date and their geochemical properties help constrain the tectonic context in which they were emplaced. This study focuses on the pre-mesozoic basement in the Sambuco and Maggia lower Penninic nappes located in the central lepontine domain of the Alps.

A number of magmatic events have been identified in the Sambuco basement. These events were dated using LA-ICPMS U/Pb on zircon grains. The mafic calc-alkaline banded Scheggia suite is dated as lower Cambrian, 540-530 Ma. The Al-rich Sasso-Nero lenticular gneiss is 480-470 Ma old (similarly to many older orthogneisses of the Alpine basement) and contains 630-610 Ma old pan-African inherited zircons that illustrate the Gondwanian origin of these terranes. The calc-alkaline Matorello pluton is dated as 310-300 Ma whereas the lamprophyric bodies it contains are of 300 Ma. The Cocco granodiorite and the Ruscada leucogranite both intrude the basement of the adjacent Maggia nappe and are of similar ages to the Matorello. The ages as well as the geochemical similarities between the Cocco, Rucada and Matorello plutons suggest their paleo-geographic proximity at the Permian-Carboniferous boundary. However, these nappes are currently considered as belonging to two different Mesozoic paleo-geographic domains. Indeed, the Sambuco is considered as Helvetic whereas the Maggia is said to be Briançonnais, both separated by an oceanic basin. If this is the case, then it is essential that no strike-slip movement has misaligned both continental margins since these coincide perfectly now that the oceanic domain closed.

The Matorello pluton was originally a tabular intrusion, built up by the accumulation of multiple, several meter-thick, subhorizontal sheet-like injections of magma. Depending on their emplacement rate, the successive magma injections either solidified rapidly with sharp and rather well-defined boundaries (like the composite sills) or mingled with previous injections generating a thick molten layer up to several tens to hundred meters thick, like in the main granodioritic facies. These coalesced injections are hardly distinguishable, however subtle contrasts in granulometry, mineral modal proportions or mineral sorting (cross-bedded biotite-rich schlieren), as well as erosional features and/or crystal entrapment along contact surfaces allow to distinguish between the different injections.

Two exceptional meter-thick layers display sinuous boundaries with the host granodiorite and consist of a densely packed accumulation of mafic enclaves in a granodioritic matrix. Gravitational sorting of the enclaves with load cast features at the base of the layers and sinuous biotite schlieren point to injection of low viscosity turbulent composite magma flows in the still largely molten granodiorite host. The hybrid nature of these rocks implies the existence of a periodically replenished and differentiated underlying magma chamber. Magmas are mafic liquids derived from the mantle and anatectic liquids of crustal origin, as shown by the $(^{87}Sr/^{86}Sr)_i$ and epsilon Nd values (0.704-0.709 and -2.1 to -4.7 respectively). These data show that the crustal contribution is important, as confirmed by the Pb isotopes. The hybridisation processes seem to have occurred in the lower crust in magma chambers underlying the Matorello laccolith. The paleo-gravity markers in the Matorello help understand the architecture of the Sambuco nappe. Isoclinal folds with a vertical axial plane can be seen at the contact between dioritic and granodioritic facies. The antiform structure of which the Matorello is the heart is in fact a syncline. This places it in the inverse flanc of the large recumbent fold that constitutes the Sambuco nappe. The gneiss blocs found in the summital wildflysh cover of the Antigorio nappe have been linked to the Matorello pluton. This means that the front of the Sambuco nappe already overlapped the Antigorio basin when it closed. This implies that the Lebendun nappe can only overlap the Antigorio nappe in it's external position.