

A preliminary prospecting programme carried out by Rimin S.p.A. has increased knowledge of the Cervo Pluton and allowed the subdivision of the mineralization as follow:

- Aplite veins (at Tomati) and coarse quartz veins (at Machetto) containing pyrite, chalcocopyrite, pyrrotite, powellite and bismuthinite are found within the syenite.
- Quartz veins and stockworks (at Sassaja) that contain zinc blende, chalcocopyrite, galena, pyrite and gold are found within a characteristic alteration of the pink porphyritic granite.
- Fine quartz stockworks, which have produced little alteration of the granite (at Campiglia Cervo) contain pyrite, chalcocopyrite, molybdenite and powellite. These are related to an intense brecciation of the core of the pluton.

The Mo-Cu occurrences (= W, Bi, and U) disseminated in the granite core, may be related to a porphyry-type model.

The Pb-Zn-Cu (Au) vein occurrences in or near the pluton, could be related to auriferous polymetallic analogous to that in the Traversella stock and at Tavagnasco.

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-  $^{40}\text{Ar}/^{39}\text{Ar}$  thermal history of Hercynian  
plutons in Northern Calabria (Italy)

A Hercynian plutonic complex ranging in composition from biotite-hornblende tonalite or granodiorite to two-mica  $\text{Al}_2\text{SiO}_5$  (andalusite, sillimanite, cordierite) granite occurs in the Sila tectonic unit in Northern Calabria.

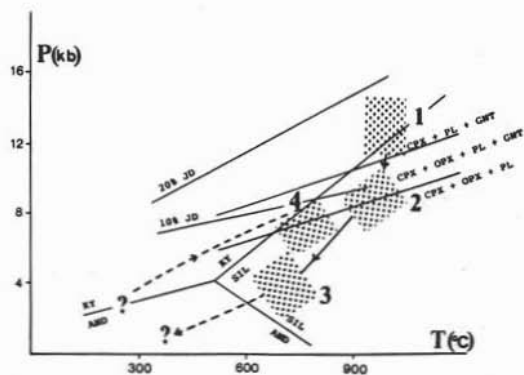
These plutons are both syntectonic (mainly biotite and biotite-hornblende granodiorite) and post tectonic (two-mica granite) with respect to Hercynian orogenesis. This Hercynian complex, together with its metamorphic country rocks, was tectonically transported from the southern continental margin of the Thethys to its present structural position during at least one stage of Alpine orogenesis. Previous geochronology suggests that mineral in the plutons variably retain their Hercynian history with many mineral pairs being only slightly age discordant suggesting that their ages are close approximations of the times of crystallization of the plutons. Potentially,  $^{40}\text{Ar}/^{39}\text{Ar}$  age spectra of hornblende, muscovite, biotite, and microcline could elucidate the chronology of emplacement and Hercynian cooling history as well as any low-temperature thermal effects from Alpine deformation. Using the argon closure temperatures and the  $^{40}\text{Ar}/^{39}\text{Ar}$  closure ages of these minerals, a time versus temperature plot for the Sila unit can be constructed. This thermal history will place constraints on both Hercynian and Alpine tectonism in northern Calabria.

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TRIBUZIO R.\*, MESSIGA B.\*\*\*, PICCARDO  
G.B.\*, VANNUCCI R.\*\* - Primary characters  
and polymetamorphic evolution of the  
Archaean basement in the Angmagssalik  
District (SE Greenland)

The Archaean basement in the Angmagssalik District consists of prevalent ortho- and para-gneisses, ultramafic and mafic (mainly amphibolite) rocks affected by later tectonic and metamorphic processes and intruded by relatively small amount of Proterozoic mafic dykes and syn/post-orogenic plutons.

Orthogneisses have granodiorite compositions, while amphibolites, in spite of the effects of chemical mobility, show geochemical record of their magmatic protholites. In fact, some petrogenetically important major and trace elements indicate an overall transitional basalt composition of arguable affinity (ocean floor? island arc?). Trace elements (Ni, Cr, Y, Ti, Nb) display good linear correlation with Zr reflecting original igneous fractionation starting from a primitive high-MgO undersaturated magma.



Ultramafic rocks represent retrograde evolution of original spinel facies lherzolites and harzburgites.

Microtextural relations and mineral chemistry show significant variations in the mineral assemblage within the same rock-types due to metamorphic reactions.

According to the chemical composition of the different systems the main relations between the different assemblages in the different mafic rock types allow the following evolution to be reconstructed:

- 1) an early event under eclogitic conditions (Na-cpx + gnt assemblage) - STAGE 1;
- 2) a subsequent partial reequilibration under granulite facies conditions (cpx + opx + pl ± gnt) - STAGE 2;
- 3) a third event with incipient amphibolitization displaying coronitic textures (horn + pl as reaction rim between cpx and gnt) - STAGE 3;
- 4) a final event with pervasive transformation under amphibolite facies conditions (horn + pl assemblage) - STAGE 4.

P-T estimates for the above evolutionary steps have been determined according to recent experimental data on the pertinent system (see Fig. 1).

Available geochronological data indicate that Arctic Shield in the Angmagssalik District underwent to main metamorphic events, the first at 2500 M.y. and the second at 1500 M.y.

Summing up petrographical and geochronological data the stages 1, 2, and 3 can be ascribed to the retrograde evolution connected to the oldest tectonometamorphic event, whereas stage 4 could represent the thermic peak of the later event.

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VILLA I.M.\* , GIANELLI G.\*\* , PUXEDDU M.\*\* ,  
BERTINI G.\*\*\* , PANDELI E.\*\*\* - *Granitic dykes of 3.8 Ma age from a 3.5 km deep geothermal well at Larderello (Italy)*

Granitic dykes, apparently 2-3 m thick, were recently found intruding basement gneiss at a depth of 3.486 m b.g.l. in the geothermal exploratory well Monteverdi 7 drilled by ENEL (Italian National Electricity Board). The well is located 4 km SW of Serrazzano, outside the present-day exploitation area, near its western margin. An intrusive body has long been considered the heat source of the Larderello geothermal field (MARINELLI, 1963). The slow cooling rates revealed by radiometric data (DEL MORO et al., 1982), the large area (> 100 km<sup>2</sup>) enclosed by the 350°C isotherm at 3.000 m depth (BATINI et al., 1985), the wide negative gravity anomaly, the regional uplift of the Pliocene shore sediments (see DEL MORO et al., 1982) and the ubiquitous presence of a seismic reflecting horizon (BATINI et al., 1983), all indicate that this intrusive body is of batholithic dimension. The composition of the batholith was thought to be granitic because the post-tectonic late Alpine magmatism of Tuscany is mainly granitic (BARBERI et al., 1971). However the drilled wells did not encounter magmatic material until the early 1980s.

BATINI et al. (1983) first described a leucogranitic dykelet crosscutting basement micaschists in well VC II at 2.946 m depth b.g.l. BATINI et al (1985) date this dykelet at 2.9 Ma by K-Ar on the biotite of the gneiss immediately surrounding the dykes. The biotite was totally reset by the dyke emplacement to an age that is about 0.5 Ma younger than the equivalent biotite from the nearby well Sasso 22. From the K-Ar and Rb-Sr radiometric data on biotites of the latter well DEL MORO et al., (1982) concluded that the main body intruded more than 3.7 Ma ago. It is plausible that an extreme differentiate (the VC II leucogranite) was emplaced later. The discovery of a granite sample in well Monteverdi 7 confirms the validity of the geological model proposed. The granite appears as a gray-whitish finegrained rock, showing equigranular hypidiomorphic texture and made up of quartz (32.3 modal %), plagioclase (28.5%), K-feldspar (25.7%), biotite + chlorite (8.8%), white mica (3.7%), opaque minerals, cordierite, sillimanite, andalusite and accessories (1.0%). Plagioclase shows a

continuous normal zoning and a composition range of 20-45% An. K-feldspar is microperthitic and of other shows granophytic textures at rims. Biotite is strongly chloritized. White mica includes both a primary mineral and a secondary microcrystalline type derived from the alteration of cordierite. Spene appears as a rare secondary product associated with chloritized biotite. Sillimanite and green spinel probably represent relics of pelitic or metapelitic rocks partially molten by granite. The composition of the Monteverdi granite is very similar to Tuscan late Alpine granites and almost identical to those of Gavorrano and Roccastrada.

A K-Ar age was obtained on a biotite freed from the chlorite by repeated gravity separation-methanol crushing. The resulting K content (7.4%) is satisfactory. Other analytical data are: <sup>40</sup>Ar<sub>rad</sub> = 1.093 nl/g, or 21.1% of total <sup>40</sup>Ar; age = 3.8 ± 0.1 Ma. The inhole temperature is between 300°C, definitely lower than the closure temperature for biotites (see discussion in DEL MORO et al. 1982). This date is encouragingly consistent with the dates and conclusions of DEL MORO et al., (1982). This date is encouragingly consistent with the dates and conclusions of DEL MOTO et al. (1982) (emplacement age higher than 3.7 Ma, see above) and is therefore also in agreement with the regional apttern of the Tuscan granite cooling ages.

Conclusions. The following geological model is proposed. The Larderello geothermal anomaly was generated by a composite batholith surrounded by dyke swarms, emplaced more than 4 Ma ago. The younger age values found in the Larderello field, i.e. 1.6 Ma on a biotite from well San Pompeo 2 (BATINI et al., 1985) and 2.5 Ma from well Serrazzano Sperimentale (DEL MORO et al., 1982) have been explained in terms of distance from the thermal top and/or efficiency of cooling induced by hydrothermal circulation.

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ZORPI M.J.\* , COULON C.\* , ORSINI J.B.\*\* ,  
COCIRTA C.\*\* - *Magma mingling, zoning and emplacement in calc-alkaline granitoid plutons*

The study of some Carboniferous orogenic granitoid plutons from Northern Sardinia reveals the close relationship between their composition and the abundance of their mafic magmatic inclusions. The latter represents blobs of mingled basaltic magma. Most of the plutons are normally zoned with their felsic character increasing towards the core. This compositional trend goes parallel with a decrease in the number of the mafic inclusions. These characteristics are found in most calc-alkaline plutons throughout the world. Moreover, in Sardinia, each studied pluton contains a population of mafic inclusions typified by a distinct FeOT/MgO ratio, suggesting that the emplacement of each intrusion is related to a single episode of mingling with a basaltic magma. On the other hand, a close chemical relationship