

New petrological results on high-pressure, low-temperature metamorphism of the Upper Palaeozoic basement of Central Chile

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KEY WORDS: Blueschist, Greenschist, Amphibole, Phengite, Coastal Range, Central Chile

INTRODUCTION

Similar to paired metamorphic belts, the metamorphic basement within the coastal ranges of Chile south of 34°S can roughly be divided into a Western Series of low grade metamorphic rocks locally containing high-pressure, low-temperature rocks (e.g. glaucophane schists) and an Eastern Series with intermediate to high grade rocks metamorphosed under low pressure conditions (Gonzalez Bonorino & Aguirre, 1971; Aguirre et al., 1972). In the Western Series metagreywackes and metapelites dominate. Subordinate are greenschists, which partly show relic pillow structures and MORB signature. Intercalated are lenses of serpentinite, massive Fe-Cu-Zn-sulphides and metacherts. The thick clastic sequences of the Western Series are probably of Silurian to Devonian sedimentary age. Metamorphic ages are not older than Carboniferous younging towards the South (Hervé, 1988). The low grade Western Series is interpreted as part of an accretionary prism (Hervé, 1988).

Because P-T data for the peak of metamorphism are very rare in the area and also related to some exceptional rocks (e.g. Collao et al., 1986), our aim was to study also the common metasediments for deciphering the P-T evolution. For that purpose, we concentrated strongly on the variable compositions of the minerals, mainly phengites and amphiboles, in the rocks. For the detailed petrological studies, we selected, so far, the following areas: (1) a region between Pichilemu and Constitucion, (2) an area around Mehuin N of Valdivia.

PETROLOGICAL RESULTS

On the basis of numerous thin sections of various rock types a selection was made to investigate some rocks with the aid of the electron microprobe in detail. So far, we have studied several metapelites, greenschists, blueschists, meta-ironstones and quartzites.

Metapelites often contain the mineral assemblage chlorite, phengite, quartz and albite. Biotite can be occasionally present. Greenschists are also characterized by a common mineral assemblage: albite, chlorite, epidote, Ca-amphibole with minor phengite and quartz. Blueschists are very similar but contain Na-amphibole instead of Ca-amphibole and occasionally stilpnomelane. The latter mineral is abundant in meta-ironstones sometimes coexisting with garnet. Stilpnomelane, zussmanite, and quartz was also found in such rock types.

Blue amphiboles from Pichilemu are crossite or glaucophane sometimes surrounded by actinolites (Table 1), which typically occur in greenschists. Phengites from blueschists can contain Si

contents around 7.0 per double formula unit, but rim compositions are clearly lower in Si and also show significant Fe^{3+} (Table 1). The same compositional feature is also typical for metapelites.

First attempts were made to apply thermodynamic mineral data for the calculation of the metamorphic P-T conditions with the PTAX software package using the variable mineral compositions (cf. Massonne, 1995). Metamorphic temperatures were in the range 300° to 400°C. Maximum pressures were around 8 kbar. During the metamorphic evolution, a significant pressure decrease occurred.

Table 1: Representative analyses of minerals from a metapelite of the Mehuin area (sample CM9) and from blueschists from Pichilemu (samples MIL3404 and MIL3409). Structural formulae were calculated on the basis of (1) 42 Val. + Na + K + Ba/2 and a maximum of 4.1 octahedral cations for phengites and (2) 15 + A cations, O = 23 for amphiboles

	Metapelite			Metabasites		
	Phengites		core 10078/96	Amphiboles		rim 10112/5
	core 10666/64	rim 10666/62		rim 10078/99	core 10112/10	
Si	6.981	6.541	6.982	6.782	7.950	7.710
Al ^[4]	1.019	1.459	1.018	0.218	0.050	0.290
Al ^[6]	2.930	2.869	2.717	2.534	1.350	0.049
Cr	0.013	0	0.004	0.004	0.002	0
Ti	0.018	0.020	0	0.003	0.006	0.005
Fe ³⁺	0	0.351	0.097	0.473	0.678	0.382
Fe ²⁺	0.452	0.172	0.423	0.114	1.155	1.623
Mn	0.009	0.013	0.006	0.006	0.018	0.039
Mg	0.600	0.675	0.853	0.965	1.792	2.902
Ca	0	0	0	0	0.065	1.721
Na	0.124	0.115	0.029	0.029	1.877	0.378
K	1.596	1.672	1.988	1.870	0.002	0.030
F	0.090	0.089	0	0	0	0

CONCLUSIONS

Generalizing our new petrological results, the Palaeozoic metamorphic rocks of the Chilean Coastal Range had experienced very similar peak metamorphic conditions at high pressures and low temperatures. However, the rocks are strongly overprinted at greenschist facies conditions. High Si phengite compositions witness the high-pressure event even in clearly retrogressed metapelites. Relics of blue amphibole prove this in metabasites. Under these circumstances, the idea that the thick clastic sequence of the Western Series is part of an accretionary prism must strongly be considered.

ACKNOWLEDGMENTS

The research project was financially supported by Billiton Minerals Chile and by the German Ministry of Research and Technology.

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