

# Geochemistry and origin of chloritoid schist from the Alpi Apuane, Italy: evidence of a prevailing lateritic signature

MARCELLO FRANCESCHELLI<sup>1</sup>\*, MARIANO PUXEDDU<sup>2</sup> and MARCO GATTIGLIO<sup>3</sup>

<sup>1</sup> Dipartimento di Scienze della Terra, via Trentino 51, Università di Cagliari, I-09127 Cagliari, Italy

\*Corresponding author, e-mail: francmar@unica.it

<sup>2</sup> Istituto di Geoscienze e Georisorse C.N.R., via Moruzzi 1, I-56124 Pisa, Italy

<sup>3</sup> Dipartimento di Scienze della Terra, Via Valperga Caluso 37, Università di Torino, I-10125 Torino, Italy

**Abstract:** Chloritoid schist layers frequently occur as the uppermost part of the Rhaetian Breccie di Seravezza Formation, interpreted as rockfall talus metabreccias intercalated between Norian and Liassic marbles, in the Alpi Apuane Tuscany, Italy. The chloritoid schist is characterised by mm-sized chloritoid porphyroblasts (20–50 % modal range) and a matrix made up of chlorite, muscovite, pyrophyllite, chloritoid, hematite, calcite, quartz and epidote. Most chloritoid porphyroblasts show cores with abundant hematite inclusions. Many pieces of duricrust, pisoid and composite pebbles come from older lateritic bauxite deposits of supposed Kasimovian to Sakmarian age. Their uneven to well rounded shapes indicate variable duration of transport and multistage reworking.

In comparison with many bauxite and metabauxites, Apuan chloritoid schist shows: great enrichment in SiO<sub>2</sub>, K<sub>2</sub>O, Na<sub>2</sub>O, a slight increase in CaO, MgO, remarkable depletion in Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub>, a slight decrease in TiO<sub>2</sub> and P<sub>2</sub>O<sub>5</sub>, strong depletion in Cu, Pb, Zn, Bi, and As, unexpected Ni, Co and Ba enrichments; slight to strong depletion for Ga, Cr, Nb, Zr, and V reflecting variable dilution of primary bauxite detritus. The REE spider diagram shows enrichment factors of 2–3 for LREE, of 1–2 for HREE. Strong enrichment to strong depletion in Sm, Eu, Gd, and Tb is correlated with maximum and minimum contents of duricrust fragments respectively.

Four detrital components were distinguished. Two of them represent about 90–95 % of the whole protolith: 1. Fe<sub>2</sub>O<sub>3</sub><sub>tot</sub>-Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub>-rich lateritic bauxite detritus; 2. illite-rich desert soil particles with high K<sub>2</sub>O, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> contents. The calculated relative proportions are: component 1): 61 %, component 2): 39 %. Minor detrital components are given by: 1) Ba-rich mineralised rock fragments, a witness to Late Triassic hydrothermal circuits; 2) detritus supplied by Na, Ca, Mg-rich salts abundant in hot desert soils. The very low TiO<sub>2</sub> and very high SiO<sub>2</sub> contents of the calculated lateritic bauxite component strongly suggest a granite to rhyolite protolith for the primary bauxite deposit, the ancestor of the Apuan lateritic bauxite component.

**Key-words:** chloritoid schist, geochemistry, lateritic signature, reworking, Rhaetian, Alpi Apuane, Northern Apennines.

## Introduction

In the last five years, we investigated manganese ore bodies (Franceschelli *et al.*, 1996) and cookeite-rich metabauxite beds (Franceschelli *et al.*, 1998) discovered only in some outcrops of the widespread Rhaetian Breccie di Seravezza Fm (BSFm).

The latter is a metamorphosed metabreccia interpreted (Franceschelli *et al.*, 1996) as a rockfall talus deposit consisting of marble and dolostone clasts embedded in a mainly carbonate matrix. In its uppermost part the BSFm is characterised by the ubiquitous occurrence of lithotypes extremely enriched in millimetre-sized chloritoid porphyroblasts whose modal values often reach 50 %. Two main lithotypes have been distinguished: chloritoid metabreccia and chloritoid schist on the basis of the abundance of centimetre- to decimetre-sized elements of white pink marble and dolostone. The aim of the present paper is to clarify the nature and origin of the chloritoid-rich lithotypes through a multidisci-

plinary approach with particular attention to the possible parent rocks that supplied detrital material to the original sediment, precursor of present-day chloritoid schist. Only a few papers are concerned, up to now in literature, with the nature of the parent rock of the chloritoid schists. Geochemical data on Apuan chloritoid schists suggest that primary bauxite deposits were the main source of detrital material supplied to the protolith. Unfortunately, scanty trace element data are available in literature on metamorphosed secondary bauxite deposits. The second goal of this paper is to supply an exhaustive set of trace element data on Apuan chloritoid schists as a contribution to knowledge of primary and secondary bauxite deposits.

## Geological setting

The most complete pile of nappes in the Northern Apennines crops out in the Alpi Apuane. From top downwards they