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Traces of Rhyolitic-Trachytic Volcanism in the Upper Jurassic of the Southern Alps: Reply

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RIASSUNTO

In un precedente lavoro gli autori (1970) segnalarono la presenza di materiali piroclastici intercalati nel Rosso Ammonitico delle Alpi Venete. In un lavoro successivo DE VECCHI e DIENI (1974) rigettano la natura vulcanica dei depositi in questione e giustificano il sanidino presente come esclusivo risultato di processi diagenetici. Un riesame del materiale ha permesso il riconoscimento nei singoli cristalli di feldspato di un nucleo di sanidino di indubbia origine vulcanica circondato da K-feldspato di origine diagenetica. Ciò è osservabile sia otticamente sui singoli minerali che attraverso la microsonda (Fig. 1-2). Resta dunque provata l'esistenza di un vulcanismo giurassico nell'area corrispondente al margine meridionale della Tetide.

Introduction

In a previous paper the present authors interpreted thin bentonitic clays intercalated in the Rosso Ammonitico Superiore Formation of the Venetian Alps as products of coeval volcanic activity (BERNOULLI and PETERS 1970). This interpretation was based mainly on mineralogical composition, namely the abundance of montmorillonite in the clay and of sanidine and biotite in the silt fraction and the lateral extent of the clay seams. In this volume DE VECCHI and DIENI (1974) have presented new evidence on the nature of the sanidine crystals and have questioned the volcanic origin of the latter and of the bentonitic clays in general. Their main arguments concern the lateral extent of the clays seams, the significance of the mineralogical composition of the clays, the amounts and significance of the different minerals in the silt fraction and the nature of the sanidine crystals, which they interpret as formed entirely by diagenetic processes. From their observations the authors conclude that *all* the clay seams intercalated in the Rosso Ammonitico Formation are of detrital origin. In this reply we shall restrict ourselves to answer the arguments brought forward by DE VECCHI and DIENI and, more specifically, to show that the particularities of the sanidine crystals are derived from diagenetic overgrowth of K-feldspar on volcanic sanidine rather than from diagenetic growth alone.

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1. Lateral extent of single clay seams

We cannot confirm the observations by DE VECCHI and DIENI (1974) that the single clay seams cannot be followed over large distances. The clay seams, described southeast of Cima Tre Pezzi (for exact location see BERNOULLI and PETERS 1970) can safely be followed to the bridge on the Ghelpach creek and can be recognized in the same microstratigraphical sequence in the quarries south of the creek. Moreover, a detailed correlation could be established with a section much further to the west along the new road from Rovereto to Serrada (personal observations by D. Bernoulli and C. Sturani); this will be described in a forthcoming paper. Admittedly, a great number of minor argillaceous intercalations are present in the Rosso Ammonitico Formation, however, as no detailed mineralogical investigations have been carried out, we do not know whether these may represent bentonites or not.

2. Mineralogical composition of the clay fraction

DE VECCHI and DIENI (1974) do not attribute any significance to the mineralogical composition of the clay fraction. Their statement that similar associations of clay minerals without any accompanying volcanicity occur throughout the Mesozoic sequence of the Southern Alps is not supported by adequate clay mineralogical studies or references to such. If confirmed we rather should revise our views on the frequency of volcanic products in the Tethyan Mesozoic: indications of Late Jurassic volcanic activity have been newly discovered in many places of the Tethyan region as e.g. in the Northern Calcareous Alps, a region which once belonged to the same palaeogeographic realm (DIERSCHE 1973; HUCKRIEDE 1971).

3. Presence of biotite and of pebbles of older rocks

There is no doubt that biotite of detrital origin occurs in many sedimentary rocks, however, the content is always very low and the ratio muscovite/biotite very high. In the Ghelpach samples almost no muscovite is present and biotite clearly predominates; this is characteristic for tuffaceous deposits. According to F. Hofmann (personal communication, 1974) the heavy mineral association in the Ghelpach samples contains apatite and zircon with a habitus similar to that of the same minerals in the Middle Triassic volcanic tuffs of southern Ticino.

It is true that there are exotic fragments of older volcanic and metamorphic rocks and minerals in the Rosso Ammonitico. However, this is not relevant to the specific problem of the bentonite seams, as such exotic blocks, usually assumed to have been transported by drift-wood, are not uncommon in pelagic deposits where rates of sedimentation are low (cf. BIRKENMAJER et al. 1960). This phenomenon certainly does not exclude that in other places bentonite layers may have a volcanic origin, even if some detrital minerals are present.

4. Quartz content

The high quartz content in the silt fraction of our samples of the volcanic layers has been confirmed by microscopical observations, whereas the amount of organically derived silica in the bentonites proper is less than 5% of the total quartz.

5. Volcanic glass

The amount of glass-like material is indeed very small and can be easely overlooked, especially as it is strongly alterated into a dense aggregate of montmorillonite.

6. K-content and presence of illite

The observation of De Vecchi and Dieni that the potassium in our analyses of the clay fractions cannot be entirely due to sanidine is correct. This high K_2O value is, however, not the result of a high illite content as they propose. The high content of presumably detrital illite in the samples of De Vecchi and Dieni must be due to strong contamination of their samples with material surrounding the thin "bentonitic" seams. Despite great care it was not always possible to avoid admixtures of country rock in some of our own samples, which resulted always in higher illite contents.

Most of the potassium is accommodated within the montmorillonite interlayer space. F. Hofmann (personal communication 1974) was so kind to measure the soda activation. The Ghelpach samples showed a similar behaviour as K-bentonites. This K-content has probably been incorporated during diagenesis, contemporary with the formation of the pure K-feldspar rims around the sanidine.

7. Plagioclase

The absence of plagioclase is due to either the absence of plagioclase phenocrysts in the original tuff which would imply a more phonolitic magma than we originally assumed or the complete decomposition of the original plagioclase crystals during diagenesis.

8.–12. Mineralogical and chemical properties of the sanidine crystals

The composition of the sanidine, on which De Vecchi and Dieni base most of their arguments, was investigated for this study on the ARL-Microprobe of the Institute of Crystallography and Petrography of the ETH (Zurich) with the help of J. Sommerauer. Almost all feldspar grains contain a sanidine core (composition $Or_{70}Ab_{30}$ with some small variations) and a rim of pure potash feldspar. The sanidine core is homogenous and shows no trace of perthitic lamellae; it has a strong blue cathode-luminescence. The K-feldspar rim is full of small calcite inclusions, probably giving rise to the red cathode-luminescence observed. These observations are illustrated in Figure 1 showing the distribution of K, Na and Ca in a composite feldspar grain.

With our data the presence of satellite reflections on the precession photographs given by De Vecchi and Dieni (Fig. 2 of their paper) are understandable. The weak reflections indicating a larger a_0 can be attributed to the pure K-feldspar rim, which has grown with the same crystallographic orientation as the sanidine core. De Vecchi and Dieni's "crypthoperthitic" hypothesis, assuming perthitic intergrowth of two potassium-rich feldspars, must be rejected on the basis of the large amount of available phase equilibrium data and the evidence presented here. Kastner (1971) (included in the reference list of de Vecchi and Dieni) demonstrated that authigenic microclines contain less than 1% of Na and Ca and authigenic albites less than 1% K.

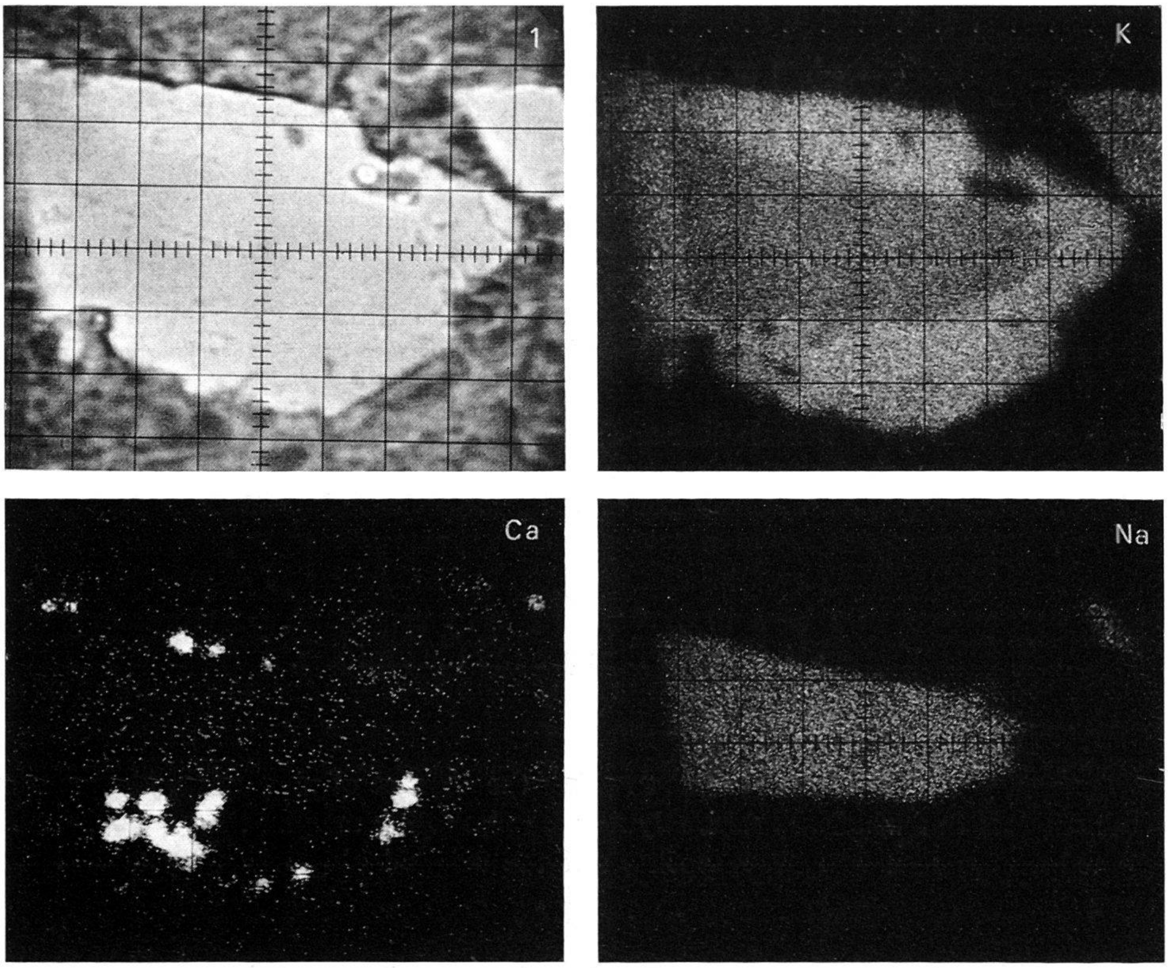

Fig. 1. Electron micrograph and K, Ca, Na X-ray images of a feldspar grain from Ghelpach, showing a sanidine ($Or_{70}Ab_{30}$) core and an authigenic K-feldspar rim with calcite inclusions. DB 3320. Gridspacing 8 μ.

Conclusion

De Vecchi and Dieni's hypothesis that the feldspar in the Ghelpach sediments are authigenic is only correct for the rim. Diagenetic overgrowth by K-feldspar on a nucleus of volcanic sanidine easily explains many of the features observed by De Vecchi and Dieni, particularly the common occurrence of euhedral crystals, the doubling of certain reflections in the precession photographs and the calcite inclusions in the overgrowth rim (cf. our Fig. 2). Descriptions of pure authigenic K-feldspars are scarce (Kastner 1971), while overgrowths of authigenic K-feldspar are more common. The physical-chemical conditions that prevailed during the formation of the K-feldspar overgrowths on the Ghelpach sanidines pose a very interesting problem, that will be discussed in a forthcoming paper.

There is no way to elude the volcanic origin of the sanidine cores. As it is very unlikely that the sanidine is derived from the Permian volcanics which contain no fresh sanidine, a contemporaneous volcanic origin of the sanidine and the accompanying montmorillonite is the only feasible hypotheses. We therefore explain the association of sanidine and montmorillonite in the clay seams by episodic deposition of cineritic material during deposition of the Rosso Ammonitico and subsequent divitrification. The occurrence of illite and other detrital minerals in the host formation is due to a perennial detrital overprint on the pelagic carbonate sedimentation.

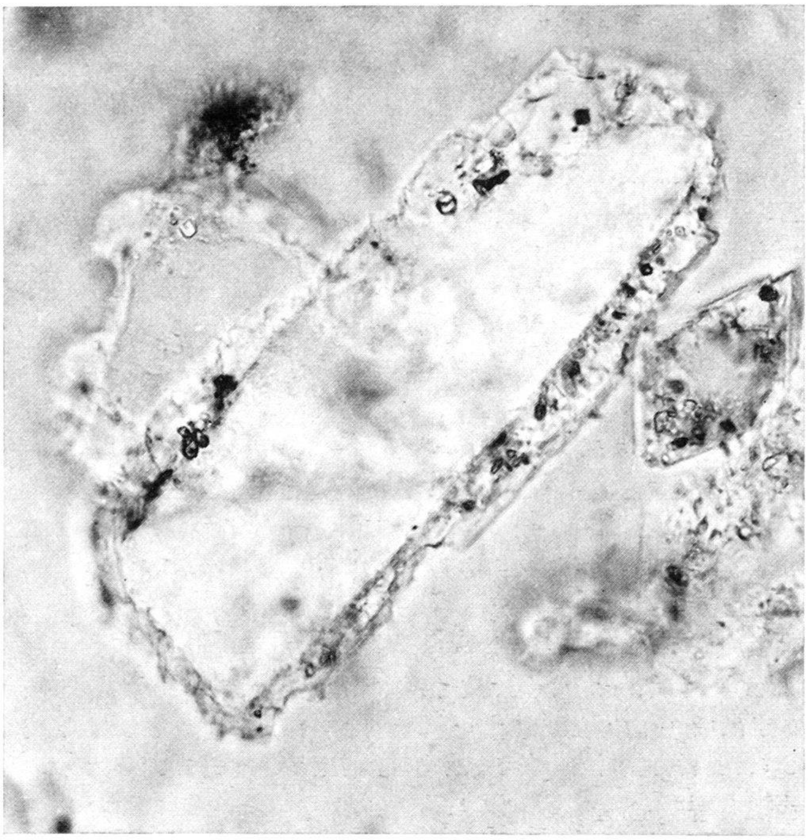

Fig. 2. Photomicrograph of Ghelpach K-feldspar with volcanic sanidine core and authigenic pure K-feldspar rim, in which a lot of calcite grains are included. Total lenght 50 μ.

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