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Weathering of leucite to clay minerals in tephrites of the Vico volcano

PAUL QUANTIN* and PAOLO LORENZONI**
* Orstom, 72 Route d'Aulnay, 93143 Bondy, France
** Ist. Sper. Studio e Difesa Suolo, P.za D'Azeglio 30, 50121 Firenze, Italy

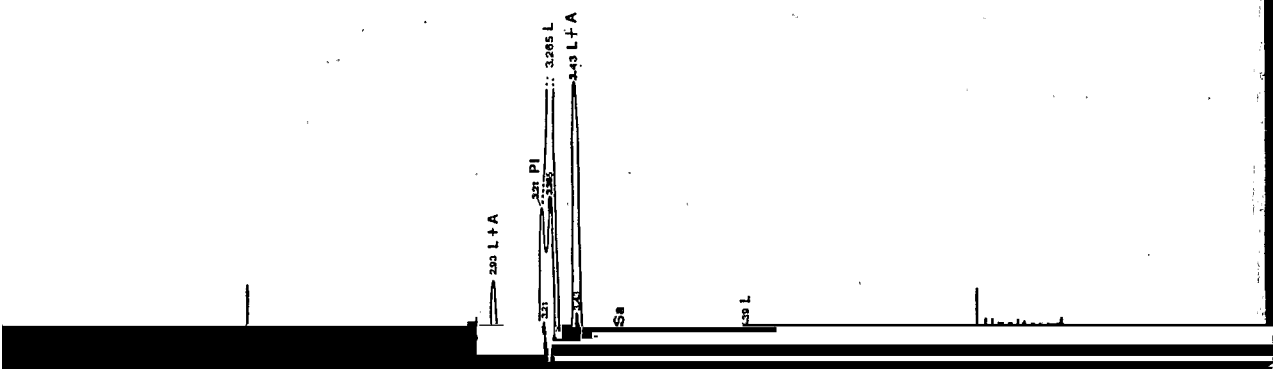
ABSTRACT — The weathering of leucite has been studied in tephrites of the Vico volcano. The petrography was made on undisturbed samples by optic and scanning electron microscopy with microprobe analysis. We follow a weathering sequence of leucite crystals from a core of lava to a first altered cortex and then in sandy and clayey arene of weathering. Then we compare the alteration in the B and A horizons of an overlying andosol, deriving from tephrite pyroclasts under a perhumid climate. We can observe also the leucite alteration in a «petrisco» (leucotephrite) under a xeric climate. The clay minerals composition was obtained from a powder of whole material and the less 2 μm fraction, by X Ray diffraction and TEM. The alteration of leucite to analcime in the first cortex is inherited from a former hydrothermal process. While clay minerals are forming by further weathering in relation with drainage intensity, e.g.: allophane and imogolite in andosols under perhumid climate and with high drainage; halloysite under less humid climate or with slower drainage.

Key words: Leucite, Weathering, Analcime, Allophane, Imogolite, Halloysite, Vico-volcano.

Introduction

A. Cundari and G. Graziani (1964) studied first the weathering products of leucite in the tephrites (leucotephrites and petrischi = acid leucotephrites) of the Vico volcano. They showed that leucite is generally altered into analcime, or eventually to kaolinite (probably halloysite after new investigation) and allophane. E. Azzaro and al. (1976) studied later the alteration processes of leucite in an incoherent and more altered tuff.

On the impulse of L. Lulli and D. Bidini we made a study of soils on the volcano of Vico (Bidini and al. 1984; Lulli and al. 1986, and 1988). P. Quantin and P. Lorenzoni (1980) made especially studies of mineralogy and micromorphology. We have namely observed the alteration of phenocrysts and volcanic glasses in various parent materials (ignimbrites, tuffs and leucotephrites), according either to their situation in a climatosequence or to the either


2.93 L+A
3.21 Pl
3.265 L
3.43 L+A
Sa
4.39 L

ly weathered at the soil bottom, under either the form of «petrisco» (altered acid leucotephrite) on the outer piedmont of the volcano, or the form of «arene» on the upper edge of the caldera. The aim of this paper is to show some features of leucite alteration in the «arene» or in the «petrisco» substratum and in an andisol as well.

Materials and methods

Material

The weathering of leucite has been ob-

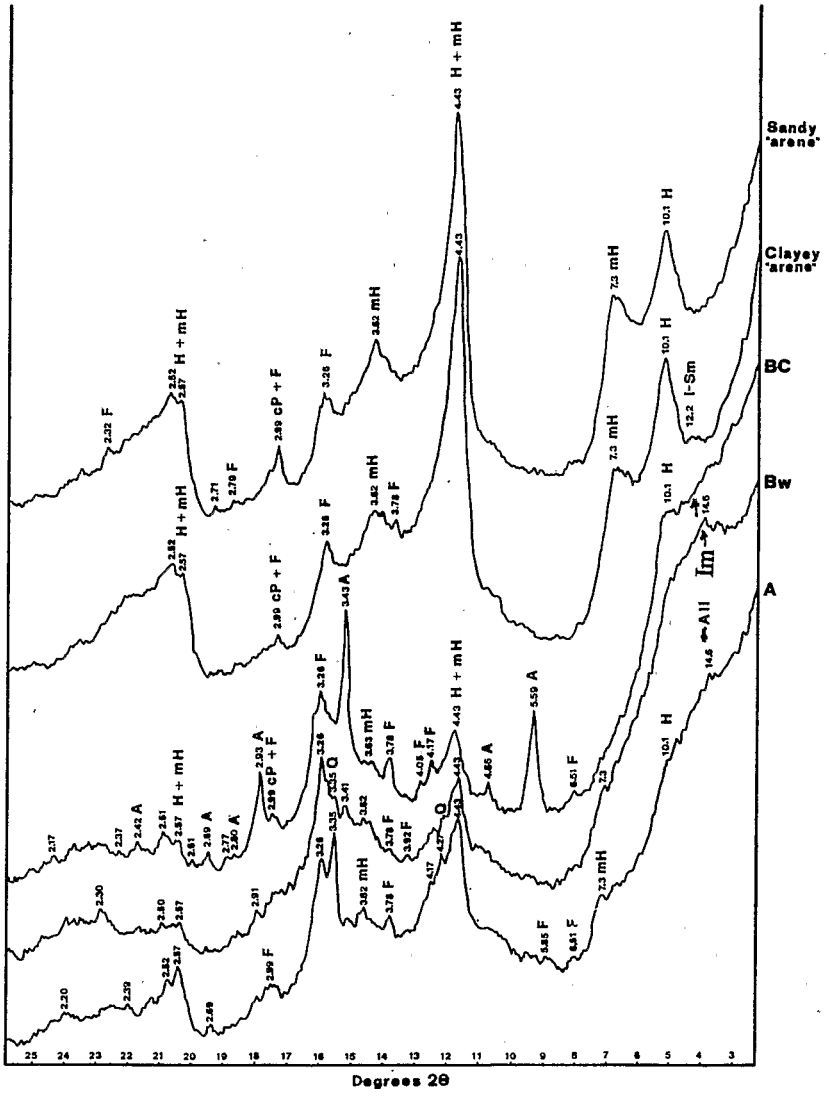


Fig. 2 - XRD on <2μm fraction of «arene» and andisol horizons. H 10 Å halloysite; mH 7 Å halloysite; F feldspar; Q quartz.

carved in an andisol (melanudand) and - the kernel of unweathered lava, the cor-

brown soil, on the outer piedmont of the volcano.

In the first site the soil has been formed under a temperate and regularly wet climate, while in the second site the soil has been formed under a climate with dry season.

Methods

For mineralogy and petrography we have used the following methods.

— X Ray diffraction: on a powder of

cotephrite by Cundari and Graziani, 1964) is a leucitic phonolite where sanidine is substituted to labradorite.

2) Powder of whole material of the «arene» and the andisol (Fig. 1): In addition to the minerals of the parent material, some products of weathering appear, like analcime and clay minerals, while the content in leucite is decreasing. In the «arene» there are two main products: analcime and 10 Å halloysite; the last one is increasing in the clayey arene. In the andisol, the analcime and the leucite are diminishing; but there are only traces of

— In the kernel of almost unaltered leucotephrite, leucite looks almost intact, polygonal, with polysynthetic twinning; it shows some inclusions of labradorite microlites.
— In the cortex, the leucite is altered around its margin and along some radial fissures, leaving some islets of unaltered mineral.
— In the sandy «arene» as well as in the clayey one, the leucite is almost completely altered, in a light yellowish product, which is isotropic in cross-light. It remains only few islets of unaltered mineral. Sometimes we observe some recrystallization of zeolites at the margin of the crystal. We note also in the clayey «arene», some palagonitized glasses, which could indicate a product of phreato-magmatic outburst.
— In the B horizon of the andisol, the leucite again is almost completely altered to a light brown and isotropic product, with some dull yellowish verge at the margin.
— In the A horizon, the small crystals of leucite which are isolated in the soil matrix are completely altered to a dull or light brownish and isotropic product; while the phenocrysts of leucite which remain included in the pyroclasts of tephritic lava are not completely altered, leaving some unaltered islets of the primary mineral. (That means a latter eruption of tephritic pyroclasts).

Scanning Electron Microscopy (SEM) and microprobe analysis

We have summarized some relevant results of microprobe analysis, after normalisation in percentage of the main elements, on the anhydrous oxides basis (Tab. 1). The «in situ» microprobe analysis allows us to specify the chemical composition of leucite and of its different forms of alteration we have observed by optic microscopy and further by SEM. The SiO_2/Al_2O_3 molar ratio (Ki) provides a good estimate of the corresponding mineral, either leucite for a value of 4.5 and high contents in K_2O, or analcime for 4.0 and high contents in Na_2O, or halloysite for 2.0, and finally imogolite for 1.1 or allophane for 1.8, according to the previous data of mineralogy.

The pure leucite in lava kernel «e» has a low content in Na. But in the cortex «d», the leucite center is altered to a

TAB. 1

Microprobe analysis of leucite and its alteration products

		SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	Ki
e	kemel	58	22	0.4	0.0	0.1	0,9	19	4.5
d	cortex	61	26	0.5	0.2	0.1	11	0.9	4.0
b	sand-arene	51	43	1.5	0.3	0.3	1-2	1-2	2.0
a	clay-arene	52	44	1,7	0,2	0,3	O.O	1.1	2.0
B	horizon	39	59	0,7	0,1	0.8	0.0	0,1	1.1
A	horizon	49	46	1.7	0.5	0.1	0.4	0.7	1.8
P	petrisco	53	44	0.7	0.2	0.7	0.9	0.0	2.0

composition corresponding to analcime (K replaced by Na). In sandy «arene b» a major part of leucite is weathered to

and with rather slow drainage (Quantin 1991). However, some relicts of zeolites can remain. That confirms the observa-