

A REPORT ON THE DERIVATION AND PROPER USE OF THE TERM ANORTHOSITE*

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ABSTRACT

The term anorthosite, coined by T. Sterry Hunt in 1862, applies only to a specific rock type. The origin of the term and a review of the definition of anorthosite are given, as well as six recommendations on relevant petrographic nomenclature. The recommendations call for adherence to the IUGS definition of anorthosite, use of modifiers where appropriate (andesine anorthosite, augite anorthosite, and so on), abandonment of such meaningless expressions as anorthositic gabbro and gabbroic anorthosite, and use of the term meta-anorthosite where evidence of igneous parentage has been erased by deformation and metamorphism.

Keywords: anorthosite, petrography, terminology.

SOMMAIRE

Le terme anorthosite, introduit par T. Sterry Hunt en 1862, se limite à un seul type de roche. L'origine du terme et un historique de la définition d'anorthosite sont présentés, ainsi que six recommandations concernant l'utilisation de sa terminologie pétrographique: l'adhésion stricte à la définition de l'anorthosite de la UISG, l'utilisation des qualificatifs tels anorthosite à andésine, anorthosite à augite, etc., l'abandon des termes erronés "gabbro anorthositique" et "anorthosite gabbroïque", et l'utilisation du terme méta-anorthosite pour les anorthosites dont l'origine ignée a été effacée par la déformation et le métamorphisme.

Mots-clés: anorthosite, pétrographie, terminologie.

INTRODUCTION

Recently, I have had the opportunity to map the "type" anorthosite (Feininger 1993). That work has served to make me conscious of the uniqueness of this venerable rock name. Nevertheless, abuse and misuse of the term anorthosite by geologists are widespread and seem unabated by the passage of time.

The aim of the present note is pragmatic: to insure the usefulness of an especially specific rock name. The text is divided into three sections. The first discusses the origin of the term anorthosite. The second section reviews the definition of anorthosite. The closing section offers six recommendations on relevant petrographic nomenclature.

"Recherches sur l'origine des roches"¹ before the Société Géologique de France in 1858. In discussing extrusive (= "true igneous") rocks, Delesse said (1858, p. 751): "Comme leur feldspath dominant est tantôt l'orthose et tantôt l'anorthose, il conviendra d'examiner successivement ces deux cas"². To clarify, Delesse added: "Le mot *anorthose* désigne ici, d'une manière générale, tous les feldspaths qui appartiennent au sixième système cristallin"³.

The 1863 compendium *Geology of Canada* implies that it was Delesse who introduced the term "anorthosite". In the compendium, a footnote reads: "Since all these varying triclinic feldspars are anorthic in crystallization, and approach more or less to anorthite in their composition, Delesse thus proposed to

ORIGIN OF THE TERM

The French geologist Achille-Ernest-Oscar-Joseph Delesse (1817-1881) read a landmark paper

¹Investigations on the origin of rocks.

²As their dominant feldspar is in some cases orthoclase and in others "anorthose", it will be suitable to look at each case in turn.

³The word *anorthose* here refers, in a general sense, to all feldspar belonging to the sixth (= triclinic) crystal system.

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designate them by the common name of anorthose, as distinguished from orthose or orthoclase, and the rocks characterized by their presence as anorthosite. In accordance with this we have adopted the generic name of anorthosite for these rocks" (Logan *et al.* 1863, p. 22). However, the term anorthosite appears nowhere in Delesse's paper or, to my knowledge, in any other of his early writings. On the other hand, tradition has it that T. Sterry Hunt coined the term. It may have been as early as 1862 (IUGS 1989, p. 47), although the first use of the term in a readily available publication was in the above-cited compendium, where in the body of the text one reads: "... destitute of quartz and composed chiefly of a lime-soda feldspar, varying in composition from andesine to anorthite, and associated with pyroxene or hypersthene. This rock we shall distinguish by the name anorthosite", and "The hypersthene is however often replaced by ordinary pyroxene, or is wholly wanting in the Laurentian system, giving rise to a purely feldspathic rock" (Logan *et al.* 1863, p. 22, 27).

The picture was clouded when, sometime between 1883 and 1888, the term anorthose in France became synonymous with anorthoclase. This synonymy was first registered in the North American literature by J.D. Dana in the 6th edition of his *System of Mineralogy*, published in 1892. Not long into the present century, however, use of the term anorthose had been abandoned, at least in English, and it was dropped by E.S. Dana in the 3rd edition of his *Textbook of Mineralogy*, published in 1922.

DEFINITION OF ANORTHOSITE

Anorthosite is a plutonic rock in the *Dictionary of Mining, Mineral, and Related Terms* (U.S. Bureau of Mines), as well as in the first edition of the *AGI Glossary of Geology*. By the second edition of the *AGI Glossary*, anorthosite had become a plutonic igneous rock, as indeed it is in R.S. Mitchell's *Dictionary of Rocks* and the *British Penguin Dictionary of Geology*, which also adds that it is coarse grained. Anorthosite is a member of the gabbro group, according to both Russians (*Geologicheskii Slovar*, Moscow) and Spaniards (*Diccionario de Geología y Ciencias Afines*, Barcelona), whereas in Tomkeieff's *Dictionary of Petrology* it is, texturally at least, merely a "granular rock".

Quantitative definitions of anorthosite pivot upon the modal composition of the rock; that it is composed "almost wholly", "essentially", or "nearly exclusively" of plagioclase which, in addition, commonly is described as "calcic" or "basic". The definitive IUGS classification states: $Q \leq 5$; $P/(P + A) > 90$; $M \leq 10$. Aside from this unpoetic definition, the *Penguin Dictionary of Geology* offers the only other current definition to set numerical limits, calling on anorthosite to contain more than 90% modal labradorite, by-

townite, or anorthite. In an earlier historical discussion, Johannsen (1937, p. 196–205) had restricted the modal abundance of mafic accessory minerals yet more tightly, setting the color index (CI) of anorthosite at no more than five.

Clearly, all definitions aim toward a general consensus, but at the same time they allow some leeway. The three categories in which leeway is evident are origin, texture, and modal composition.

Origin

Anorthosites are conveniently divided into the anorthosites of layered mafic intrusions and the massif anorthosites. The igneous parentage of anorthosites in layered intrusions is generally obvious, particularly where such intrusions are pristine or have been only feebly modified by deformation or metamorphism. Many massif anorthosites, on the other hand, are extensively recrystallized, and their ultimate origin cannot be read in the field or under the microscope. Furthermore, they may carry assemblages of metamorphic minerals, and mineralogical disequilibrium may be reflected in corona textures. In short, probably all anorthosites began as igneous rocks. Many were subsequently deformed and recrystallized to a point where they have the characteristics of metamorphic rocks.

Texture

Anorthosites of layered intrusions typically are plagioclase cumulates. They are composed of crowded euhedral to subhedral cumulus plagioclase, and small amounts of intercumulus mafic minerals. Grain size is mostly medium to coarse. Massif anorthosites, on the other hand, exhibit a much wider spectrum of textures, commonly within individual outcrops. They range from massive to intensely foliated and lineated rocks. Some exhibit layered structures. Many anorthosites are extremely coarse, among the coarsest rocks known, composed of jammed-together giant crystals of plagioclase up to a meter long. Recrystallization is common in massif anorthosites, and a medium- to fine-grained granoblastic matrix supporting bent relics of large crystals of plagioclase is a particularly widespread texture. In places, massif anorthosites have been comminuted to the point where superficially they resemble aplites.

In summary, the textures of anorthosites vary enormously, ranging from igneous to wholly metamorphic. Grain size extends from pegmatitic to aphanitic. Fabric may be massive, intensely foliated and lineated, or anywhere between these extremes.

Modal composition

Anorthosite is a plagioclase rock. Accessory mafic

minerals are chiefly pyroxene, olivine, and oxides; hornblende and biotite are rarer. Some metamorphosed anorthosites carry accessory garnet. The highest modal content of dark minerals allowed is mostly unspecified, although a few authors venture to cite 5 or 10%. One form or another of a scale of rock types bridging anorthosite with gabbro and spanned by such vague terms as gabbroic anorthosite and anorthositic gabbro is commonplace. Nevertheless, it must be pointed out that such usage does not conform to the IUGS scheme, under which the color index of gabbro sweeps across the wide gap from anorthosite ($CI \leq 10$), to ultramafic rocks ($CI \geq 90$).

RECOMMENDATIONS

In a personal effort to arrest what appears to be unending disorder in the use of the term anorthosite, I offer the following six recommendations:

1. Anorthosite is a specific rock type, and the name should at no time be diluted by application to rocks that are not anorthosite. For this purpose, the IUGS definition ($Q \leq 5$; $P/(P + A) > 90$; $M \leq 10$) should be adhered to strictly.
2. The plagioclase of anorthosite is commonly cited as "calcic" or "basic", with at least the allusion that it must not be more sodic than labradorite. This is misleading because the plagioclase of many anorthosites (including the type anorthosite: Feininger 1993) is andesine. By the IUGS definition, the plagioclase of anorthosite may fall anywhere between An_{05} and An_{100} . To clarify, "andesine anorthosite", "labradorite anorthosite", and so on are useful terms and may be used where appropriate.
3. A sample of anorthosite characterized by a specific mafic accessory mineral may advantageously have its name modified. Thus, olivine anorthosite, augite anorthosite, and ilmenite anorthosite are legitimate terms. For each, of course, the color index of the rock must be less than ten.
4. Anorthosite is a noun and must not be used as an adjective to modify other rock names. "Anorthositic gabbro" is meaningless and should be replaced by a term such as leucogabbro.
5. In order to preserve the singularity and usefulness of the term anorthosite, such terms as "gabbroic

anorthosite" and "anorthositic gabbro" must be abandoned, to be replaced by "leucogabbro" or yet more specific terms as warranted by individual situations. Such usage can be precise and succinct. One example suffices. The gradation of an anorthosite with accessory orthopyroxene (modal plagioclase, 97%; enstatite, 3%) into a more mafic rock (modal plagioclase, 88%; enstatite, 12%) should be described as a transition from anorthosite to leuconorite. A few bare words carry a detailed message.

6. Whereas most anorthosites ultimately have some sort of igneous parentage, diverse massif anorthosites have had their primary textures erased by deformation and metamorphic recrystallization. Such rocks are best referred to as meta-anorthosite.

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