On the Terms « Ignimbrite » and « Ignimbritic Deposits » *

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The purpose of this article is an attempt to give a definite determination of the term « ignimbrite » and thus to avoid the confusion, which is still observed in the interpretation of this term.

There is no need to repeat all the numerous terms that have been associated with the term « ignimbrite » or which have even been its synonyms. They have been quoted in many articles and in particular in R. L. SMITH's papers and in his memorandum read at the International Symposium on Volcanology in Japan in 1962.

The suggestion that is going to be made is, actually, to a certain extent very similar to the suggestions made previously by many authors. At the present time we should try to arrive at a common understanding of the events and materials associated with ignimbrites.

We know that P. MARSHALL, who introduced this term, gave the following description:

« The actual method of eruption was probably similar in its general nature to that described by Fenner as associated with the sand flow at Katmaii... Fenner describes the eruptive material there as similar to ignited fine carbonate of magnesia, which flow like a liquid. Lacroix compares its condition with that of milk when boiling over, and considers the eruptive matter to have been a type of nuée ardente. The type of rocks formed in this way varies greatly, but it is suggested that they should all be included in a separate group, for which the name « Ignimbrite » seems satisfactory ». (P. MARSHALL, *N. Z. Jour. Sci.*, vol. 13, No. 4, p. 200, 1932).

In another article published in 1935 P. MARSHALL wrote at its beginning (on p. 323): « In order to avoid difficulty and confusion in nomenclature in speaking of the rocks that are dealt with in this

* Paper read at the IAV International Symposium on Volcanology (New Zealand), scientific session of Nov. 25, 1965.

paper, this preliminary statement is made. These rocks are regarded as formed by an eruptive process similar in its nature to that which was described by Fenner as acting at Katmaii in Alaska. In other words, they are thought to have been deposited from immense clouds or showers of intensely heated but generally minute fragments of volcanic magma. The temperature of these fragments is thought to have been so high that they were viscous and adhered together after they reached the ground. Since this type of rock mass has a wide occurrence in New Zealand, but has not been recognized before except by FENNER, who calls it « indurated sand flow rock », it appears that a new term is required for its designation. Rocks which are thought to have been formed in this manner are here called Ignimbrites ».

And at the end of this article (on p. 360) P. Marshall indicates that « Ignimbrite is used as a name for a tuffaceous rock of acid composition that has been formed from a « nuée ardente katmaïenne » in the nomenclature suggested by a Lacroix » (P. MARSHALL, *Roy Soc. N. Z. Trans.*, 64, p. 323, p. 360, 1935).

These definitions of ignimbrite are not very clear. According to the first article the word « ignimbrite » can be regarded as a volcanological term, while, according to the second paper, it is rather a petrographic term — a name of a rock.

In this way the double meaning of the term resulting from the above mentioned definitions lead to a confusion in its interpretation and use.

The term « ignimbrite » received a varying interpretation (Fig. 1).

Some scientists used it to designate a volcanic body — a formation consisting of loose, partly welded components (mostly volcanic glass) of an acid composition formed as result of an eruption of a gas-ash flow.

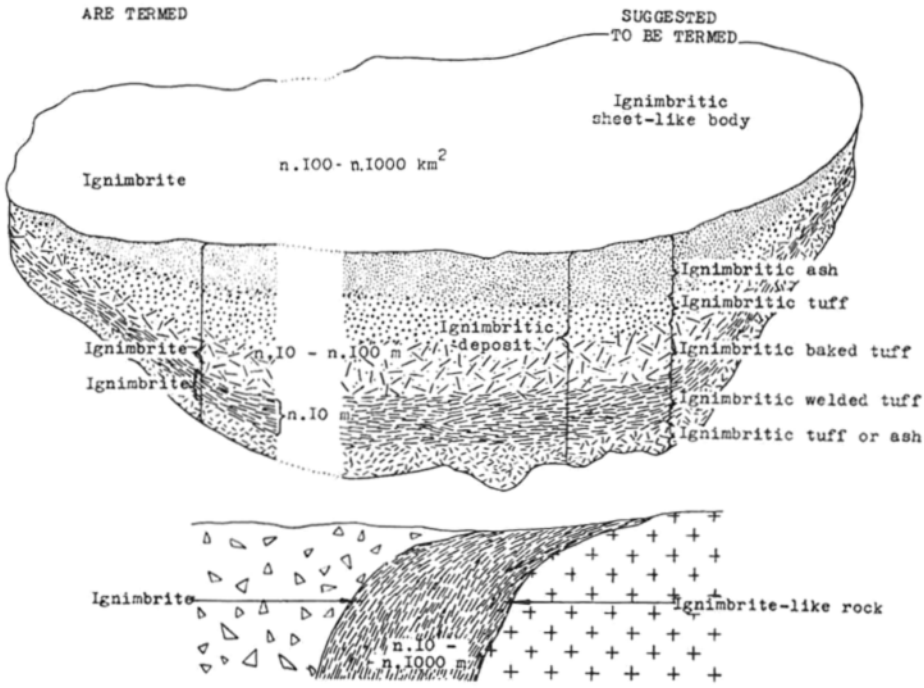
Others regarded the term « ignimbrite » as uniting the entire group of rocks of ignimbritic deposits, *i. e.* loose at the bottom, welded higher up, partly welded even higher and changing later into unbaked loose deposits.

A third group give the name of ignimbrite only to the welded part of such deposits.

A fourth group think that the term ignimbrite is an analogue of the terms tuff or lava without any indication of its mineralogical or chemical composition, but denoting deposits of a big size both as to area and thickness with a definite (indicated above) distribution of its components.

Some authors used this term also for intrusive rocks.

There has been a tendency to replace the word « ignimbrite » by other terms, which, in the opinion of their authors, better corresponded to the formation processes of « ignimbrite ». Some geologists have stopped using it, as it does not convey any clear meaning.



All this happened because two different concepts became mixed — a special type of eruption, and rocks, formed as results of this special type of eruption.

This is one of the main reasons for a different interpretation of this term. Another not less important reason is the genesis of lenticular (fiammae) and otherwise shaped fused fragments of volcanic glass formed in the pyroclastic deposit as a result of a caking or melting of clastic material.

The possibility of fragments melting to form relatively big amounts of « lenses » and other shapes has not been accepted by many geologists on the basis of their knowledge and observations of the eruptions of many different volcanoes. So far, nobody has been

witness to an eruption which caused similar fused forms to originate over extensive areas.

Different doubts have been expressed regarding the genesis of these forms and other hypothetical explanations have been offered.

The genesis of the fused part of ignimbrites is still not quite clear, though a number of papers described experimental studies by SMITH, BOYD and other researchers, which confirm the possibility of a fusion of rhyolitic fragments under a certain pressure and the presence of volatiles at temperatures beginning with 535°C (according to Smith) and 600°C (according to Boyd); they also show that eruptions, which can produce welded tuffs of an ignimbritic type, should be characterized by a tremendous mass of a nearly entirely juvenile material ejected during a relatively short time interval, as has been indicated recently in papers by P. BORDET, G. MARINELLI, M. MITTEMPERGHER and H. TAZIEFF. Considering these facts it is most probable that the fusing of fragments of an acid volcanic glass could take place also during the formation of ignimbritic deposits.

It is, however, possible to assume not a pyroclastic, but a lava nature of welded tuffs in ignimbritic deposits.

In this way, one can assume that in the process of eruption as a result of which ignimbritic deposits were formed, the explosive eruption was replaced by a gas-ash flows at first or effusions of flows of foamy lava or flows of a mixture of clastic material, and lavas that had been mixed in the vent of the volcano or maybe, by some other type of eruption replaced again by an explosive eruption.

Consequently, the formation process of the fused part of ignimbrites is not generally accepted yet. There are different assumptions. As mentioned at the beginning of this paper, even Marshall himself said that ignimbrites are *assumedly* a rock of an indurated sand flow.

Though the genesis of the fused part of ignimbritic deposits is to a certain extent disputable, still names should be suggested both for this type of eruption and for its products.

In this problem it is necessary to divide two concepts: i) a special type of eruption and a volcanic body, ii) rocks formed as a result of these eruptions.

Not every pyroclastic flow can produce baked or, particularly, welded products. Apparently, they can be formed only be especially thick and very hot gas-ash flows. Such a special type of eruption results in the formation of big volcanic bodies occupying an area of several hundreds or thousands square kilometers, being up to several

hundreds meters thick and having a sheet-like shape. They consist in their bottom parts of comparatively thin loose, mostly pumice deposits gradually changing upwards into first welded and then denser welded deposits, which higher change again into partly baked and then unbaked loose deposits of a nearly identical mineralogical and chemical compositions mostly corresponding to acid rocks. It is suggested (despite the terming of this type as Katmaiian by some authors) to call this type of eruption an *ignimbritic* (or ignimbrite) *type of eruption.* It is suggested to call the mentioned volcanic bodies *ignimbritic* (or ignimbrite) *deposits* consisting of ignimbritic rocks: with an obligatory mention of a word characterizing the given species of the rock, *i.e.* in this case, ash or loose, baked and welded.

It is also necessary that every term, and especially a scientific term, has an absolutely definite meaning and this means that the petrographical composition of ignimbritic rocks should be indicated.

Such a definition details the content of these terms and, it seems to me, eliminates a confusion in their interpretation.

In this way, it is suggested for the mechanism of the formation of the above mentioned extensive volcanic bodies to use the term « *ignimbritic* » denoting a special type of eruption, which is, apparently, a special variety of eruptions creating pyroclastic flow, and for the deposits formed as a result of an ignimbritic type of eruption — the term « *ignimbritic deposits* » consisting of « *ignimbritic rocks* ». For instance: « *ignimbritic rhyolitic ash* », « *ignimbritic rhyolitic tuff* », « *ignimbritic rhyolitic baked* (or partly welded) *tuff* », and « *ignimbritic rhyolitic welded tuff* ».

Discussion

M. H. Battey: When one surveys the compositions of rocks that have been called ignimbrite it is seen that they have quite a wide range of composition (especially in silica content). It is therefore necessary to apply a qualifier to the name ignimbrite to denote the composition of the rock. This might be done either by using terms like ignimbritic rhyolite, ignimbritic dacite etc. Professor Vlodavetz has performed a useful service in bringing forward a proposal of this kind and it will help to clarify future discussions.

A. Rittmann: Ignimbrite is a general term, like lava, ash, tuff etc. It defines only the mode of eruption and deposition but does not say anything about the chemical or mineralogical composition of the resulting rock.