

Descriptive Nomenclature and Classification of Pyroclastic Deposits and Fragments

Recommendations of the IUGS Subcommittee on the Systematics of Igneous Rocks
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With 1 figure and 2 tables

Zusammenfassung

Die „IUGS Subcommittee on the Systematics of Igneous Rocks“ unterbreitet hier ihre Empfehlungen für die Benennung und Klassifizierung pyroklastischer sowie gemischt pyroklastisch-epiklastischer Ablagerungen auf Grund deskriptiver, hauptsächlich granulometrischer, Kriterien. Diese Empfehlungen sind das Resultat einer internationalen Umfrage mittels Fragebogen, die sich über die letzten vier Jahre erstreckte.

Abstract

The IUGS Subcommittee on the Systematics of Igneous Rocks herein presents its recommendations on the nomenclature and classification of pyroclastic and mixed pyroclastic-epiclastic deposits using descriptive, mainly granulometric, criteria. The recommendations are the result of an international inquiry by means of questionnaires during the last four years.

Résumé

La »Subcommission on the Systematics of Igneous Rocks« de l'IUGS présente ici ses recommandations pour la dénomination et la classification des roches pyroclastiques et pyroclastiques-épiklastiques selon arguments descriptives, surtout granulométriques. Ces recommandations représentent le résultat d'une enquête internationale exécutée pendant les quatre années passées.

Краткое содержание

Международная комиссия по систематике эруптивных пород, а также их составных частей – „IUGS“ – предложила анкету. Здесь приводятся результаты опроса и предложения, как отдельных ученых, так и учреждений о классификации эруптивных пород.

Introduction

During the last four years, a period when working meetings of the subcommittee were dealing with pyroclastic deposits, six questionnaires on the descriptive nomenclature and classification of pyroclastic rocks were circulated to more than 150 geologists throughout the world. One of the questionnaires accompanied an issue of the Bulletin Volcanologique. The answers were carefully analyzed to obtain representative opinions, upon which the recommendations in this paper are based. The recommendations have been ratified by the Subcommittee at its Paris meeting in July 1980.

From the beginning, the Subcommittee aimed at a descriptive, rather than a genetic, classification suited for field use, including a minimum number of terms,

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and based mainly on the granulometric properties of pyroclastic deposits. The Subcommittee also intended to compile a separate glossary of common volcanoclastic rock terms, but this endeavor is still incomplete.

Comments on the recommended definitions and classification

The following paragraphs outline the reasons for our final choice of nomenclature and classification summarized in the next section.

The term "pyroclast"

The answers on the questionnaires exhibited a major difference among active workers on pyroclastic rocks on the question of how broadly the terms "pyroclast" and "pyroclastic deposit" should be defined. One group, represented by geologists whose chief concern is pyroclastic rocks, prefers to restrict "pyroclastic deposits" to subaerial fall, flow and surge deposits, and to use the median grain diameter (of the non ballistic components) as a base of the granulometric classification. Another group, which is composed mainly of palaeovolcanologists and geologists dealing only temporarily with pyroclastic rocks prefers to include within the term "pyroclastic deposits" also lahars, subsurface and vent deposits (hyaloclastites, intrusion and extrusion breccias, tuff dikes, diatremes, etc.). Because experienced volcanologists frequently cannot clearly recognize the specific genetic origin of a volcanoclastic rock in the field (e. g. to distinguish hyaloclastites from other types of pyroclastic rocks), the Subcommittee recommends that "pyroclastic deposit" be used in a broad sense. It defines "pyroclast" as "... generated by disruption as a direct¹⁾ result of volcanic action" instead of "... generated by disruption during volcanic eruptions", pyroclastic deposits being "... assemblages ... of pyroclasts". Moreover it allows "pyroclastic deposits" to contain up to 25 % by volume of epiclastic, organic, chemical sedimentary, and diagenetic admixtures. The extended meaning of "pyroclast" is not in contradiction with the linguistic content of this term, "pyr" denoting fire and "clast" breakage.

The terms "agglomerate" and "pyroclastic breccia"

Following the preference of many volcanologists, "agglomerate" is applied to coherent as well as to incoherent materials, whereas "pyroclastic breccia" refers to mainly consolidated materials because the term "breccia" is traditionally used for coherent materials.

The term "tuff"

How broadly should the term "tuff" be defined? The answers on this question ranged from "consolidated ash" to "all consolidated pyroclastic deposits". Two advantages would result if "tuff" were defined in the broad sense:

1. "Tuff" could be used as a complementary term to "tephra".
2. Coming generations of earth scientists would be free to replace "pyroclastic

¹⁾ The adjective "direct" excludes autobrecciation of lava flows, because the lava flow itself is the direct result of volcanic action, not its brecciation.

breccia" and "agglomerate" by the terms "block tuff", and "bomb tuff", thus reducing the number of basic descriptive pyroclastic rock terms and using for polymodal or poorly sorted pyroclastics self-explanatory composite terms such a "ash-block tuff" or "bomb-lapilli tuff".

The Subcommittee decided to make only one step in this direction by using "tuff" not only for ash-size materials, but also, as "lapilli tuff", for coarser pyroclastics. If the term "tuff" is used alone it should comprise, however, ash-size materials only.

Granulometric classification

In their definitions, the pyroclasts are characterized, in addition to other properties, by their size using as a quantifier the "mean diameter". In very coarse and in consolidated pyroclastic deposits the "mean diameter" is usually estimated by eye whereas in incoherent materials it can be determined by sieving. Because there does not exist a standard procedure which could be prescribed for measuring the mean diameter in all cases in the same way, the Subcommittee declines to define this term.

Instead of the "median diameter"²⁾, the more generalized term "average diameter" has been used in the granulometric classification of pyroclastic deposits taking into account that granulometric analyses will rarely be carried out and that generally the grain size will be estimated by eye.

The Subcommittee, in deciding on appropriate granulometric size limits, would have preferred to divide the granulometric scale at 50, 2 and 0.05 or 0.1 mm. Because these numbers are not even numbers on the phi-scale widely used by sedimentologists, the 64, 2 and 1/16 mm limits were chosen. These numbers, however, have to be regarded as provisional as long as international agreement on granulometric divisions of sedimentary rocks is lacking. When in future such an agreement is achieved it may be necessary to modify them so that they will fit appropriate sedimentary size limits. Sedimentologists are invited to reinforce their efforts to establish a unified granulometric classification of sediments.

Genetic prefixes

The terms for pyroclastic deposits cited in the following chapter may be prefixed by further terms denoting the specific genetic origin of the deposit or the chemical composition of the parent magma, e. g.: "air fall tuff", "lacustrine tuff", "laharic ash-lapilli tuff", "rhyolitic crystal tuff", "vent agglomerate" etc. The terms may also be replaced by purely genetic terms such as "hyaloclastite", "base surge deposit", etc., whenever it seems appropriate to do so.

The term "epiclast"

The definitions of "epiclast", "epiclastic deposit", and "epiclastic rock" given on page 799 have to be regarded as provisional because they fall outside the competence of the Subcommittee. They had to be given to clearly delineate pyroclasts and pyroclastic deposits from epiclasts and epiclastic deposits.

²⁾ The median diameter of the grain population of a deposit is the diameter by which the area below a weight % frequency distribution curve is divided into two equal parts.

Recommended definitions and classification

Pyroclasts

- **Pyroclasts** are the individual crystals, crystal fragments, glass and rock fragments generated by disruption as a direct result of volcanic action. Their shapes accomplished during disruption or during subsequent transport to the primary deposit must not have been altered by later redeposition processes. If so, the crystals or fragments would be called “reworked pyroclasts”, or “epi-clasts” (if their pyroclastic origin is uncertain).
- **A bomb** is a pyroclast with a mean diameter commonly exceeding 64 mm. Its shape (ellipsoidal, discoidal, or irregular) or its surface (e. g. “bread crust” surface) indicates that during its formation and subsequent transport it was in a wholly or partially molten condition.
- **A block** is a pyroclast with a mean diameter exceeding 64 mm, whose commonly angular to subangular shape indicates that during its formation it was in a solid state.
- **Lapilli** are pyroclasts of any shape, with mean diameters of 2 to 64 mm.
- **Ash grains** are pyroclasts with mean diameters smaller than 2 mm.
- **Dust grains** (or fine ash grains) are pyroclasts with mean diameters smaller than 1/16 mm.

Pyroclastic deposits: general terms

- **Pyroclastic deposits** (= “pyroclastics”) include both consolidated³⁾ and unconsolidated assemblages of pyroclasts. They must contain more than 75 % pyroclasts by volume.
- **Pyroclastic rocks** are predominantly consolidated pyroclastic deposits.
- **Tephra** is a collective term for pyroclastic deposits which are predominantly unconsolidated.

Pyroclastic deposits: terms for unimodal and well sorted pyroclastic deposits (Tab. I and Fig. 1)

- **A pyroclastic breccia** is a pyroclastic rock whose average pyroclast size exceeds 64 mm and in which angular pyroclasts predominate.
- **An agglomerate** is a pyroclastic rock or deposit whose average pyroclast size exceeds 64 mm and in which rounded pyroclasts predominate.
- **A lapilli tuff** is a pyroclastic rock whose average pyroclast size is 2 to 64 mm.
- **A tuff** (or **ash tuff**) is a pyroclastic rock whose average pyroclast size is less than 2 mm.
- **A dust tuff** (or **fine ash tuff**) is a pyroclastic rock whose average pyroclast size is less than 1/16 mm.

³⁾ “Consolidated” as used here and in the following is thought to comprise adjectives such as “coherent”, “cemented”, “indurated”, etc.

Aufsätze

Tab. I Granulometric classification of pyroclasts and of unimodal, well sorted pyroclastic deposits.

clast size	pyroclast	pyroclastic deposit	
		mainly uncon- solidated: tephra	mainly consolidated: pyroclastic rock
64 mm	bomb, block	agglomerate, bed of blocks or bomb, block tephra	agglomerate, pyroclastic breccia
2 mm	lapillus	layer, bed of lapilli or lapilli tephra	lapilli tuff
1/16 mm	coarse ash grain	coarse ash	coarse (ash) tuff
	fine ash grain (dust grain)	fine ash (dust)	fine (ash) tuff (dust tuff)

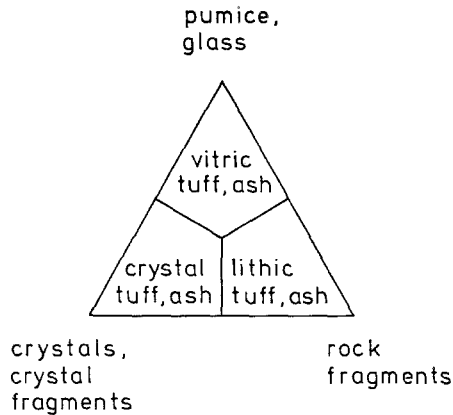


Fig. 1. Subdivision of tuffs and ashes according to their fragmental composition.

Polymodal or poorly sorted pyroclastic rocks containing pyroclasts of more than one dominant size fraction should be named by using an appropriate combination of terms cited in Table I, e. g.:

- ash-lapilli tuff (lapilli > ash)
- lapilli-ash tuff (ash > lapilli)
- lapilli tuff-breccia/-agglomerate (lapilli ~ blocks/bombs)
- (ash) tuff-breccia/-agglomerate (ash ~ blocks/bombs)
- ash-lapilli tuff-breccia/-agglomerate (lapilli ~ ash ~ blocks/bombs)

Epiclastic and epiclastic deposits

- Epiclasts are crystals, crystal fragments, glass and rock fragments that have been liberated from any type of preexisting rock (volcanic or nonvolcanic) by weathering or erosion and transported from their place of origin by gravity, air, water, or ice.
- An epiclastic deposit is a consolidated or unconsolidated aggregate of epiclasts.
- An epiclastic rock is a mainly consolidated epiclastic deposit.

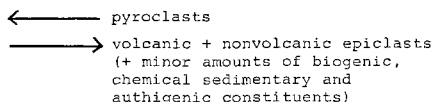
Mixed pyroclastic-epiclastic rocks

- Tuffites are rocks consisting of mixtures of pyroclasts and epiclasts (< 75 % pyroclasts, < 75 % epiclasts by volume).

Tab. II Terms for mixed pyroclastic-epiclastic rocks.

pyroclastic *)	tuffites (mixed pyroclastic-epiclastic)	epiclastic (volcanic and/or non- volcanic)	average clast size in mm
agglomerate, agglutinate pyroclastic breccia	tuffaceous conglomerate, tuffaceous breccia	conglomerate, breccia	64
lapilli tuff			2
coarse (ash) tuff	tuffaceous sandstone	sandstone	1/16
fine	tuffaceous siltstone	siltstone	1/256
	tuffaceous mudstone, shale	mudstone, shale	
100%	75%	25%	0% by volume

*) terms according to table I



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