

Primary volcanoclastic rocks: COMMENT and REPLY

COMMENT: doi: 10.1130/G23685C.1

Richard B. Waitt

*Cascades Volcano Observatory, U.S. Geological Survey,
1300 SE Cardinal Court #100, Vancouver, Washington 98663, USA*

White and Houghton (2006) propose to expand broad terms like “ash” and “lapilli” into the detail of classic Wentworth (1922) sedimentary grain-size terms. Creating a scheme where none has existed is laudable, but this one is flawed.

Use of terms like ash and lapilli for volcanic sediments in place of standard grain-size terms like sand and gravel stems from historical accident. Principles of objective grain-size measurement and terminology developed in nonvolcanic terrains (Udden, 1914; Wentworth, 1922; Krynine, 1948; Pettijohn, 1949; Folk, 1954; Folk and Ward, 1957), while volcanoes were studied by petrologists little interested in details of fragmental deposits. The term ash has for decades included the whole grain-size range from coarse sand to clay. Even when divided into fine and coarse components (e.g., Wentworth and Williams, 1932; Fisher, 1961, 1966), “coarse ash” has encompassed the entire sand range, -1 to 4ϕ ; only two volcanic terms defining eight grain-size grades (very coarse sand to clay). Mount St. Helens’ 1980 eruptions distributed sediment by surge, flow, fall, lahar, debris avalanche, etc. The descriptive grain-size terminology sufficiently divided to classify all of these was the Wentworth scale—one numerically defined name (e.g., coarse sand) for each full phi-size interval readily identified in the field. As we discussed erupted fragmental ejecta in the field at Mount St. Helens in the mid-1980s, Richard Fisher said, “they’re volcanic on the way up but sediment on the way down.” And the textbook he co-authored with H.-U. Schmincke presents volcanoclastic grain size in Wentworth terms (Fisher and Schmincke, 1984). Problems arise only if genetic implication is incorrectly read into terms like “medium sand” or “pebble gravel” that have always described grain size alone.

In place of Robert L. Folk’s (1954, 1964–1980) 15 terms describing bodies of mixed grain sizes that are readily distinguished in the field, White and Houghton’s (2006, their Fig. 1) ternary grain-size diagram contains four broad terms that are gross lumpings, inadequate even for field description.

Most scientists acknowledge a mental discipline: objectively describe first, interpret later, and keep the two separate. A classification restricted to “primary” volcanoclastic deposits needs to infer genesis first, though often one cannot know this. White and Houghton define primary as “not stored at any time” (p. 677). What about secondary pyroclastic flows; loose sand held on proximal steep slopes before flowing to valley floors? What about lahars shed off volcanoes as swiftly as pyroclastic flows? What about hybrid deposits that are half snow? Having tentatively distinguished primary from secondary, is one to apply two sets of descriptive terms to deposits differing mainly by inferred genesis? A deposit formed by pyroclastic surge is “medium ash” but where redeposited as lahar is instead “medium sand” (White and Houghton, Table 1, p. 671)? A primary fall deposit (“medium lapilli”) becomes “pebble” gravel on the stream fan below—though grain size and texture are identical (White and Houghton, Table 1, p. 671)? This seemed silly in 1980 and still does. A standard grain-size term like large-pebble gravel works as well for a pumicous-fall deposit as it does for a beach deposit.

White and Houghton refer to standard sedimentologic texts but misapply many definitions in their Table 1. For grain size -1 to 0ϕ , White and Houghton’s Table 1 is missing the adverb “very” from columns 5

and 6. The column 5 terms are not those for “unconsolidated sedimentary deposits” as claimed, but rather for particle-size class. “Granule” is a particle size between -2ϕ and -1ϕ ; the equivalent term for a deposit is “granule gravel” (Wentworth, 1922; Folk, 1954, 1980). Ditto for other terms at the bottom of column 5—where “pebble,” “cobble,” and “boulder” are misdefined. The traditional boundary between pebble and cobble is -6ϕ , and between cobble and boulder is -8ϕ . The numerical limits on the bottom three rows of Table 1 are off. And at the top of Table 1, column 5 omits silt (4 to 8ϕ). For the composite size class finer than sand (finer than 4ϕ), the usual term is “mud,” not clay (Wentworth, 1922; Folk, 1980), and for sediment bodies the term is also mud. Clay designates only the mud fraction finer than 8ϕ .

Since the 1950s, angularity of grains has disassociated from grain-size terms such as “sand” or “cobble.” I disagree with White and Houghton’s (2006, p. 678) assertion that “genetic connotations also attach to terms derived from sedimentary geology, such as ‘mudstone,’ ‘sandstone,’ and ‘conglomerate.’” These terms have long defined grain size alone, implying nothing about genesis. Folk is clear on this in his primary papers (Folk, 1954; Folk and Ward, 1957) and in each edition of *Sedimentary Rocks* (Folk, 1964–1980). Like his predecessors Wentworth, Krynine, and Pettijohn, Folk clearly intends size only—and makes no implication whatever to inferred genesis.

Wentworth’s terms, employed almost universally to describe grain size of terrestrial or marine particles or of bodies of particulate rock, work as well for the description of primary pyroclastic sedimentary deposits. The need for a separate terminology is dubious despite its long practice by some volcanologists focused on specialized topics. In a comprehensive field project like mapping, which examines all deposits on a volcanic cone regardless of inferred genetic origin, two parallel and duplicative sets of terms to describe something so basic as grain size is needlessly arcane. Superfluous size terms like “ash” and “lapilli” are better abandoned than amplified into a duplicative nomenclature.

REFERENCES CITED

- Fisher, R.V., 1961, Proposed classification of volcanoclastic sediments and rocks: *Geological Society of America Bulletin*, v. 72, p. 1409–1414, doi: 10.1130/0016-7606(1961)72[1409:PCOVSA]2.0.CO;2.
- Fisher, R.V., 1966, Rocks composed of volcanic fragments and their classification: *Earth-Science Reviews*, v. 1, p. 287–298, doi: 10.1016/0012-8252(66)90010-9.
- Fisher, R.V., and Schmincke, H.-U., 1984, *Pyroclastic Rocks*: New York, Springer-Verlag, 472 p.
- Folk, R.L., 1954, The distinction between grain size and mineral composition in sedimentary-rock nomenclature: *The Journal of Geology*, v. 62, p. 344–359.
- Folk, R.L., 1964, 1968, 1974, 1980, *Petrology of Sedimentary Rocks*: Austin, Texas, Hemphill Publishing Co. (pagination varies).
- Folk, R.L., and Ward, W.C., 1957, Brazos River Bar—A study in the significance of grain size parameters: *Journal of Sedimentary Petrology*, v. 27, p. 3–26.
- Krynine, P.D., 1948, The megascopic study and field classification of sedimentary rocks: *The Journal of Geology*, v. 56, p. 130–165.
- Pettijohn, F.J., 1949, *Sedimentary Rocks*: New York, Harper and Bros., 526 p.
- Udden, J.A., 1914, Mechanical composition of clastic sediments: *Geological Society of America Bulletin*, v. 25, p. 655–744.
- Wentworth, C.K., 1922, A scale of grade and class terms for clastic sediments: *The Journal of Geology*, v. 30, p. 377–392.
- Wentworth, C.K., and Williams, H., 1932, The classification and terminology of the pyroclastic rocks: *National Research Council Bulletin*, no. 89, p. 19–53.
- White, J.D.L., and Houghton, B.F., 2006, Primary volcanoclastic rocks: *Geology*, v. 34, p. 677–680, doi: 10.1130/G22346.1.

J. D.L. White

Department of Geology, University of Otago, P.O. Box 56, Dunedin, New Zealand

B. F. Houghton*

Department of Geology & Geophysics, School of Ocean & Earth Sciences & Technology, 1680 East-West Road, Honolulu, Hawaii 96822, USA

We thank Richard Waitt for his interesting Comment (2007). Though his views clearly do not reflect our own, published discussion is a valuable contribution to the evaluation of any newly suggested terminological scheme. Although Waitt may disagree with our assertion (2006, p. 678) that “genetic connotations also attach to terms derived from sedimentary geology, such as ‘mudstone,’ ‘sandstone,’ and ‘conglomerate,’” we remain of the view that such terms do have genetic connotations for most geologists. One indication of this is that Waitt’s own publications stand virtually alone in describing deposits of clear primary volcanic origin (as defined in White and Houghton, 2006) as sediments, whereas thousands of publications treat granulometrically equivalent primary volcanoclastic deposits with one or another volcanoclastic terminological scheme. We tested this assertion by contrasting an “eruption AND ash” keyword search on the Web of Science with an “eruption AND (sand NOT ash)” search on the same site. The former returned 74 hits for papers published in 2006, while the latter only generated 6 hits, and none of those addressed primary deposits.

Waitt’s claim that neither grain shape nor origin play a role in the naming of clastic rocks, other than when volcanologists mistakenly use them to name volcanoclastic rocks, is hard to accept given the widespread use of terms such as breccia, talus, etc. Even Folk’s useful laboratory textbook (1964–1980), which provides a detailed size classification table for siliciclastic sediments, presents a completely different set of names, divided into different size classes, for clastic carbonate sediment. (The 1980 version is now online at <http://www.lib.utexas.edu/geo/folkready/folkprefrev.html>.)

It seems clear that the Udden-Wentworth (1914, 1922, respectively) scheme is not as universal and non-genetic in application to particulate deposits as Waitt suggests. Researchers in various fields have found reason to employ specific terminological schemes, and this practice is likely to continue because of its utility. Richard Fisher’s quote, cited by Waitt, about primary volcanoclastic particles being volcanic on the way up and sedimentary on the way down, sums up Fisher’s perceptive approach to interpreting volcanoclastic deposits. Fisher did not, however, describe the volcanoclastic deposits he worked with as sand, sandstones, and conglomerates, but rather as ash, tuffs, and lapilli tuffs. Nor did Fisher do this by “accident” as suggested by Waitt; Fisher, in fact, argued the case for volcanoclastic terms at length in articles and books spanning more than 30 years (see Fisher and Smith, 1991, and citations therein).

Incidentally, there is a scheme universally acceptable throughout science for describing particulate material and deposits, and it has the additional advantage of being precise to any level desired. It is understood by scientists across all fields, and truly lacks any connotations whatsoever regarding particle shape or origin. It is the metric system, not the Udden-Wentworth scale.

REFERENCES CITED

- Fisher, R.V., and Schmincke, H.-U., 1984, *Pyroclastic Rocks*: New York, Springer-Verlag, 472 p.
- Fisher, R.V., and Smith, G.A., 1991. Volcanism, tectonics and sedimentation, in Fisher, R.V., and Smith G.A., eds., *Sedimentation in Volcanic Settings*: SEPM Special Publication 45, p. 1–5.
- Folk, R.L., 1964, 1968, 1974, 1980, *Petrology of Sedimentary Rocks*: Austin, Texas, Hemphill Publishing Co., (pagination varies).
- Udden, J.A., 1914, Mechanical composition of clastic sediments: *Geological Society of America Bulletin*, v. 25, p. 655–744.
- Waitt, R.B., 2007 Primary volcanoclastic rocks: Comment: *Geology*, doi: 10.1130/G23685C.1.
- Wentworth, C.K., 1922, A scale of grade and class terms for clastic sediments: *The Journal of Geology*, v. 30, p. 377–392.
- White, J.D.L., and Houghton, B.F., 2006, Primary volcanoclastic rocks: *Geology*, v. 34, p. 677–680, doi: 10.1130/G22346.1.