believe, are a manifestation of the same actinic effects that we have long been familiar with in certain inorganic substances. Indeed, beginning with the red rays of light at one end of the scale and ending with the hardest X-rays and gamma rays at the other, we find physiological effects differing chiefly in degree and corresponding in intensity with the actinic strength of the respective rays.

What the bio-chemical processes are that are set going by radium, or by the more familiar forms of actinic energy, we are in no position to say. From experiments with radium upon eggs Schwartz proposed that all of the effects of radium upon tissues were due to decomposition of lecithin. Hussakof suggests from experiments of Willcock, Zuelzer and Körnicke that oxygen in some not understood way seems to play a part in the process. There is every reason to believe that the process is not explicable by any simple chemical reaction. Radium rays do not produce an immediate effect upon living tissues, similar to the reduction of silver salts, for example. They have an effect upon the life processes of the cells, and these after a relatively long time produce the results that we recognize as a radium reaction. In other words the process is a vital process, and one, doubtless, involving all of the chemical complexity of cell life itself.

BIBLIOGRAPHY

HUSSAKOF, LOUIS. *Medical Record*, July 20, 1907. Action of radium on plants and animals (full summary and bibliography).

HALKIN. *Archiv f. Dermat. und Syph.*, 1903, LXV., p. 201 (histology).

DOMINICI and BARCAT. "Archives des Maladies du cœur, des vaiseux et du sang, 1908" (histology).

DOMINICI. *Archives Générales de Médicine*, July, 1909 (histology).

GUILLEMONT. "Archives of the Röntgen Ray," Vol. XV., No. 3, August, 1910. (Effects on seeds and plants and biochemistry.)

BARLING. *Brit. Med. Jour.*, July 30, 1910 (histological effects on malignant growths).

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SPECIAL ARTICLES

ON THE CLASSIFICATION OF SAND GRAINS

PROFESSOR W. H. SHERZER has just published an important paper containing a classificatcn of sands[1] in which a successful attempt is made to use origin as the primary factor for determining subdivisions. I say successful, because I believe Sherzer's classification to be a sound one for the reason that it is a natural one. In detail, as he himself says, it requires further amplification, but I believe that its leading features will stand. He distinguishes the following types: (1) *Glacial sand type,* (2) *volcanic sand type,* (3) *residual sand type,* (4) *aqueous sand type,* (5) *œolian sand type,* (7) *organic sand type,* (8) *concentration sand type.* The first five of these are clastic, the others are non-clastic. To the clastic he might have added as number 6 the artificially produced sands (or mechanico-organic) which no classification can afford to neglect, and to the non-clastic might be added, for completeness sake, (9) the granular snow and the firn or nevé, precipitated from the atmosphere, and (10) lapilli of igneous origin, but not pyroclastic. With the glacial sand group (1) Sherzer compares those formed by avalanches and rock slides, by rock and mud flows, and by earth movements along joint planes, *i. e.,* the familiar fault sand. He also adds the sand produced in the manufacture of talus, but this, when not due to mechanical slipping, clearly belongs under his residual type.

As thus included, the mechanical abrasion sands: glacial, fault, etc., come under the heading of *autoclastic sands,* and the series given by Sherzer, with the addition of the artificial sands, corresponds exactly to subdivisions of clastic rocks which I published in 1904,[2] as shown in the following table, where the corresponding divisions of my

[1] W. H. Sherzer, "Criteria for the Recognition of the Various Types of Sandgrains," *Bull. Geol. Soc. America,* Vol. 21, No. 4, pp. 625–662, pls. 43–47.

[2] A. W. Grabau, "On the Classification of Sedimentary Rocks," *American Geologist,* Vol. 23, pp. 228–247, April, 1904.

classification are numbered to agree with Sherzer's types. The technical terms for the mechanical types of the second column make for uniformity as well as euphony, while lending themselves readily to compounding.

A. CLASTIC SANDS

(Exogenetic)

Sherzer's Types of Sands

1. Glacial, etc., sand.
2. Volcanic sand.
3. Residual sand.
4. Aqueous sand.
5. Æolian sand.
6. (Artificial sand) added.

Corresponding Divisions in Grabau's Classification

1. Autoclastic sand or *autoarenyte.*
2. Pyroclastic sand or *pyrarenyte.*
3. Atmoclastic sand or *atmoarenyte.*
4. Hydroclastic sand or *hydrarenyte.*
5. Anemoclastic sand or *anemoarenyte.*
6. Bioclastic sand or *bioarenyte.*

B. NON-CLASTIC SANDS

(Endogenetic)

Sherzer's Types of Sands

7. Organic sand.
8. Concentration sand.
9. (Snow and firn sand) added.
10. (Lapilli or igneous sand) added.

Corresponding Divisions in Grabau's Classification

7. Biogenic sand.[3]
8. Hydrogenic sand.[3]
9. Atmogenic sand.[3]
10. Pyrogenic sand.[3]

In my classification of sedimentary rocks, I pointed out that after the determination of the agent, the further subdivision of clastic rocks must be on the basis of texture, and that three textures are to be recognized as of primary importance, namely, (1) *rudaceous texture,* the texture of rubble or material coarser than sand (*i. e.,* approximately above 2 to 2.5 mm.), (2) *arenaceous texture* or the texture of sand (2.5 to .05 mm.) and (3) *lutaceous texture* or the texture of mud, *i. e.,* rock flour, clay, etc. These three types of texture produce rocks, consolidated or unconsolidated, which may be classified as *rudytes, arenytes* and *lutytes,* respectively. Rudytes and lutytes are found in each of the divisions in which arenytes are found; we have *autorudytes* and *autolutytes, hydrorudytes, hydrolutytes* and all the rest, just as we have the various arenytes given above. Sherzer too is fully of the opinion that the coarser- and finer-than sand particles should be classified on the same basis as the sand itself.

Non-clastic, granular material constitutes sands, etc., only in the broader or popular sense of the term; while it is quite proper to speak of organic or chemical sands, it is desirable that the technical terms arenyte, lutyte, etc., be restricted to clastic rocks only.

Professor Sherzer further subdivides his types on the basis of reworking by some other agent. Thus he has an aqueo-residual type in which grains originally of residual (atmoclastic) origin are reworked by water. On the other hand, a residuo-aqueous type is one in which original aqueous sands (hydroclastic) have become weathered under the influence of the atmosphere. These two subtypes may be termed, respectively, the *hydro-atmoclastic* and the *atmohydroclastic* subtypes of sands. In like manner the other combinations may occur and we may have *anemohydro-,* atmo- and autoclastic sands, *hydro-anemo-,* atmo-, pyro- and autoclastic sands, *anemo-atmo-,* hydro-, pyro- and autoclastic sands, terms which have at least the advantage of euphony over the English equivalents, such as æolo-aqueous or residuo-æolian. But the selection of terms is a minor matter, the important thing being the correct classification on a genetic basis, and this Professor Sherzer has done for sands. I am happy to find myself so fully in accord with him, and that in the endeavor to classify materials he has come to substantially the same results that I have reached in approaching the matter from the more theoretical basis of principles of classification.

It may perhaps be questioned if the secondarily enlarged æolian sand grains which Professor Sherzer claims as concentro-æolian should be included in this classification, which is essentially one of the material in its orig-

[3] These are not arenytes in the sense used above —*i. e.,* for clastics only.

inal or unaltered form, while secondary enlargement of sand grains is a diagenetic process and so belongs to the subject of metamorphism.

Primarily the question is one of the admissibility of the non-clastic or endogenetic granular deposits to the group of sands, even in a popular sense. We would hardly speak of a bed composed of *Stromatopora* heads as a boulder bed, although when subject to wear on the margin of a reef the original purely organic (biogenic) mass passes into a hydrorudyte. In like manner the purely biogenic or hydrogenic granular or powdery accumulations (bioliths and hydroliths) may be transformed into clastics by one or another of the exogenetic agencies. Thus a purely biogenic (phytogenic) or a chemical (hydrogenic) oolite may become an æolian or anemoclastic rock and the same is often true of foraminiferal or molluscan shell accumulations, as in the cases cited by Sherzer.

It would be advantageous if we could restrict the use of the term arenyte to sands of clastic origin, *i. e.*, destructional sands in which the texture is *arenaceous,* and use some such term as *granulite* for constructional sand rocks in which the texture is *granulitic.* Such sands of organic (biogenic) origin form *biogranulites;* of concentrational (hydrogenic) origin (chemically formed oolites), *hydrogranulites* or, as in the case of granular snow of atmospheric (atmogenic) origin, *atmogranulites. Pyrogranulites* may be taken as another type, illustrated by lapilli, which can not be considered as truly clastic as in the case of volcanic sand. Coarser-than-sand masses of endogenetic origin might be classed as *spherites,*[4] and finer as *pulverites.* We may thus speak of *biospherites* and *biopulverites, hydrospherites,* and *hydropulverites, pyrospherites* (volcanic bombs), etc., and should thus have our deposits of clastic and non-clastic materials classified by texture. Thus a *Stromatopora* bed or one made up of *Girvanella* would be a *biocalcispherite,* an organic oolite or a sand of small shells would be a *biocalcigranulite,* while common chalk would be classified primarily as a *biocalcipulverite.* A biocalcigranulite may be subject to wind action and so become a hydroclastic biocalcigranulite. It would ultimately pass into an anemocalcarenyte. It might be objected that such terms are too complex and difficult, but only a slight examination will show that they consist of logical combinations of a few easily comprehended terms. When understood, it will be conceded that such terms make for precision not only in expression, but also in thinking.

While I thus would urge the improvement of the terminology, I fully agree with Sherzer as to the principles on which his classification is based. I would merely again emphasize the importance of making a primary division into clastic (exogenetic) and non-clastic (endogenetic) sands and I would suggest the addition to the former of the division of bioclastic (chiefly the artificial sands) and to the latter the atmogenic snow and hail, and the pyrogenic sand or lapilli.

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[4] There is no danger of confounding this with the mineral sphærite.

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 454th regular and annual meeting of the society was held in the hall of the Public Library, April 18, 1911, 8 P.M., with the president, Dr. Fewkes, in the chair. The following were elected officers for the ensuing year:

President—Mr. F. W. Hodge.
Vice-president—Dr. J. R. Swanton.
Secretary—Dr. T. Michelson.
Treasurer—Mr. J. N. B. Hewitt.
Additional Members of the Board of Managers—Messrs. G. C. Maynard, G. R. Stetson, E. T. Williams, W. H. Babcock and Dr. E. L. Morgan.

It was voted to hold bi-weekly meetings at 4:45 P.M. on Tuesdays in the new National Museum instead of once a month at 8 P.M. as formerly; evening meetings to be held as the board of the society shall desire.

There was a joint meeting of the Washington Anthropological Society and the Medical Society of the District of Columbia at the New Masonic Temple on May 3, 1911, at 8 P.M. with Dr. Barton, president of the Medical Society, in the chair.