U.S. Geological survey.
Reports. Open file series.

U. S. Geological survey.
Reports Open file series. Translations 1 to 5 (articles on engineering geology) by Mrs. Severine Britt.

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GEOLOGICAL SURVEY

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TRANSLATIONS OF FIVE FRENCH PAPERS RELEASED

Translations of five French papers on various phases of engineering geology have been placed in open file by the Geological Survey, Director William E. Wrather announced today.

1. "Choice of materials most suitable for ballast", by Leo Maddalena, describes the properties needed for good railroad ballast material. Important rocks of Italy and general rock types, such as granite, syenite, lavas, sandstones and limestones, are considered with respect to their structure, texture, compaction, accessory elements, porosity, alteration, and strength. Five pages.

2. "Special problem caused by the epigenetic alterations of Liassic rocks", by Henry Joly and Ninck, describes damages to the foundation of a building in Nancy due to swelling of a Jurassic shale bed. The swelling was due to the formation of calcium sulphate by chemical reaction of constituents of the shale resulting from circulation of damp air in the shale bed. Remedial measures are described. Seven pages.

3. "Protection of roads against rock falls", by Leo Maddalena, describes the relation between rock falls and the degree of fissuring and the mineralogy of the rocks involved. The characteristics of various types of rocks are outlined and suitable types of protection described. Four pages.

4. "Geology applied to modern highways", by Leo Maddalena, is a study of the contribution of geologic work to the construction of a heavy-duty highway through rugged terrain in the Apennine Mountains of Italy. Ten pages.

The above four papers are from the "Congres International des Mines, de la Metallurgie et de la Geologie Appliquee", vol. 2, Paris, 1935.

5. "Tests and researches on building stones", by M. R. L'Hermite and L. Feret, is a detailed report of tests made on nine limestones by the Laboratory of Building and Public Works, Paris, in 1943. Correlations are made between various properties of the stones such as composition, density, porosity, crushing strength, difficulty of dressing, elastic constants, permeability to water, resistance to abrasion, and thermal expansion. Thirty-one pages, twenty-one figures.

These translations, made by Mrs. Severine H. Britt, may be inspected in open files at the Geological Survey, Room 1033 (Library) Federal Works Agency Building, Washington, D. C., and in Building 12-B, Denver Federal Center, Denver Colorado. A limited number of copies of the translations have been mimeographed, and, as long as the supply lasts, copies can be obtained by those directly interested by writing the Director, U. S. Geological Survey, Washington 25, D. C.

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Translation No. 1

CHOICE OF MATERIALS MOST SUITABLE FOR BALLAST
(A translation)

Maddalena, Leo _/, Choix des matériaux les plus aptes pour le ballast;

_/ Maddalena, Leo, Engineer, Professor, Chief Inspector of Ministry of Traffic, Italy.

Géologie appliquée à la Construction et à l'Entretien du Reseau des Chemins de Fer italiens, Congrès International des Mines, de la Métallurgie et de la Géologie appliquée, Paris, 1935, vol. II, p. 561-565.

Translation by Mrs. Severine Britt, U. S. Geological Survey, 1946.
This is an abridged translation. The parts omitted are references to specific sites of local interest only.

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Present railroad traffic conditions, with heavier trains, greater speeds, and especially the great development of electric traction, require ballast to be made of sharp-edged rock fragments instead of rounded gravel.

The material should be of such quality as to form a strong and elastic foundation and an adequate protection for the ties. This fact should be emphasized: the properties of the materials used for ballast are different from those required for macadam roads. It is evident that for roads, a compact mosaic or real concrete is required; whereas, railroad ballast must not acquire with time any cohesion which would prevent the greatest permeability to rain waters.

Consequently, ballast should not have any binding or cementing power which would cause moist rock dust to acquire cohesion when dry, holding the rock fragments between which it is compressed. In contrast, binding power is desired and is the most important property required of macadam. For this reason, neither pure nor dolomitic limestones are very suitable materials for good ballast, whereas they are preferred for roads. To the contrary, siliceous rocks, which are generally poor for use in macadam roads, constitute the best materials for railroads.

Study of the most important rocks in Italy
in connection with their use as ballast

Granite.—Poor for macadam because of brittleness due to the presence of quartz in the rock, and due to the lack of cohesion of the debris. These characteristics do not prevent the rock from being good ballast if fine and regular-grained types without notable quartz and mica are chosen. Quarry chips are very good materials for railroad needs.

Syenites and diorites.—May be better ballast than granite because they contain little or no quartz. Porphyry and porphyrite make the best ballast. These rocks differ in texture from the granitic types. Porphyritic texture consists of larger crystalline elements scattered in a groundmass generally consisting of a fine network of microcrystalline elements which make the rock very tough.

In general, the rocks in which feldspars predominate are subject to kaolinization of the feldspars, and these finally alter into an incoherent clayey substance. Even if the kaolinization is incipient, observable only by examination of thin sections, it has a great influence on the properties of toughness, hardness, and various other factors of strength. It is because of their advanced state of kaolinization that many granites from Calabre are not suitable for ballast.

Eruptive rocks.—Trachytes and liparites are rocks of a very light shade; the first group is rich in quartz, the second is without quartz.

Trachytes are unstable materials, with variable qualities, generally poor. After experience, they have been excluded for use as ballast.

Liparites, which contain no quartz and are generally fine-grained with compact texture, present good qualities.

Lavas from active volcanoes (Etna, Vesuvius) and those from recently extinct volcanoes make very good ballast unless they are altered.

But the best materials are basalts and diabases, which may be considered as lavas from old volcanoes. The hills between Verone and Vicence provide a good ballast of this kind. These rocks have the very great advantage of being easily broken into polyhedral prisms, due to fracturing produced by the rapid cooling of the lava mass.

Arenaceous rocks.—Among sedimentary rocks are the arenaceous rocks which may be considered to result from the cementation of fine sands by a binding material which may be siliceous, calcareous or argillaceous. The adhesiveness of the binding material may vary greatly according to its nature, and consequently, we will have materials which (although classified under the same name of "arenaceous rocks") may offer qualities of very different strengths. There is no doubt that some arenaceous rocks may provide an excellent ballast, especially those belonging to old geologic horizons and composed mainly of quartzite granules with siliceous cement and few flakes of mica.

However, most of the arenaceous rocks have a calcareous-argillaceous or even argillaceous cement (Appenins rocks) and contain notable amounts of mica. It is then a material of low strength, very porous, frost-riven, and liable to disintegrate easily, forming an abundance of dusty particles. One should beware of this material and also its variability in strength, which is often due to the great diversity of superposed strata which can be found in the same quarry.

Calcareous rocks.--The great variation in calcareous rocks depends on the texture and the aggregating and contaminating substances (saccharoid, crystalline, subcrystalline, siliceous-aphanitic, dolomitic, marly, argillaceous, etc.). As a rule, only the subcrystalline calcareous rocks and those containing silica diffused in the mass, even in small quantity, may be really good ballast materials. Saccharoid, calcareous rocks, and marly or argillaceous rocks should be avoided; the others are materials which may be used, but are of low durability.

Further, calcareous rocks have the important property of being soluble in water containing carbonic acid such as all rain waters. This property is greater in dolomites because magnesium carbonate is about 4 times more soluble in rain water than is calcium carbonate. Calcareous rocks will be less soluble if the proportion of magnesium carbonate is lower; however, the property is still important because the solution of bicarbonate penetrates the ballast and deposits the carbonate causing cementation. This disadvantage has been noted where Angera dolomite was used as ballast in the Milan-Arona railroad.

Serpentine rocks.—Another important group of rocks suitable for ballast are the serpentine rocks (ophites). They result from the alteration of olivinite, pyroxenite and amphibolite. These rocks, like their parent materials (peridotites, diabases, gabbros), and the amphibolites and "prasinites" which belong in the category of greenstones, may generally be very good ballast materials. This is due to the hardness of their constituents and their high specific gravity, if they are compact and fine-grained. Consequently, they should be preferred to any others if they have the characteristics just described. Greenstone rocks (amphibolites, prasinites, etc.) are made of rod-shaped crystals; their behavior is variable, and each case requires a careful mechanical analysis.

Conclusion

In practice, it is difficult to make an a priori distinction between good and bad material.

It is true that many factors of every kind may modify the qualities of a rock even in deposits close to each other, and sometimes even in the same quarry. These factors are: structure, texture, state of compaction, presence of accessory constituents, penetration by other substances, state of freshness, susceptibility to cracking, parting, breaking, shrinking, etc.

If the preceding geologic and mineralogic criteria may serve as a guide in the preliminary choice of deposits to be exploited, one should not neglect laboratory tests, however, and still less consider them to be useless. The main tests are: abrasion, freezing and thawing, compression, and absorption.