

simultaneously with mine. I made no effort in my own paper to present new facts regarding the geology of the salt dome fields, but attempted simply to discuss a theory which, though well-known, has been neglected in American literature.

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### *ROCK CLASSIFICATION FOR ENGINEERING.*

*Sir:*—Below are some notes with reference to the classification of rocks, for the use of civil engineers, which I think will be of some interest, and I hope will start discussion along this line.

In Volume 12, page 281, of *ECONOMIC GEOLOGY*, John Graham Mitchell, formerly assistant professor of geology of the University of Oregon, broached this subject in a communication to the journal. The writer, during the past summer, was engaged in a similar investigation for the same railroad company in Oregon, though the locality and conditions were different. In his communication Professor Mitchell called attention to the very urgent need for a better system of classification than that now in use, and I wish to go into this matter a little more at length.

The classification of rocks given in geology handbooks is too technical and too clumsy, as now arranged, for the use of the field engineer, and we find in the literature nothing very adequate which the engineer can use. In some cases he has fallen back on a classification something like this, which all geologists will recognize as being a very loose and unsatisfactory classification. For instance, I found the following classification in use by the engineers of this railroad: (1) Solid rock, (2) sandstone, (3) cement, (4) shale, (5) earth.

Now all geologists know that there are many different kinds of solid rocks and many different kinds of sandstones and so on. No regard is paid in this classification to the differences in cementing materials in the sandstones; there is nothing in here about structure, or texture, which determine the ease or difficulty in excavating the material. No attention is paid to whether the material is weathered or to the degree of alteration. For instance the word cement may include many different kinds

of cementing substances, silica, calcium carbonate or iron oxide, and it makes a great difference which one of these is the binding substance.

A good classification will probably have to include terms generally used by geologists, but these must be so grouped that we get in any one group materials which can be excavated with about the same degree of ease or difficulty, as the case may be. In the following proposed classification very heterogeneous substances are grouped together, but taking into consideration texture, structure, and composition, we think there is included those materials which, from our experience, we judge ought to be classed together for similar rating in regard to excavation.

We realize that this classification is open to criticism, but criticism is what is invited, for an excellent way to develop a good classification is to propose one, have it criticized, and then make a new one, or if necessary several new ones.

In the case of a small job, involving little financial outlay, where not very much can be either made or lost by the contractor, the old loose classification as now used might be retained, but with a big piece of work, where thousands of cubic yards of rock have to be moved, it will pay both the company and the contractor to have a geologist. If the company retains no geologist on its staff then let it secure the temporary services of one, and have him classify the material to be excavated. In this particular case I know that several hundred dollars could have been saved.

For use in connection with this classification we think that Pirsson's "Rocks and Rock Minerals," with the tables there included for rock determination, should be used. There is no escaping the fact that the engineer must know the common rocks and minerals. If he does not know them now, he must either take a course where he can learn these, or a geologist must be retained.

The following classification has four main groups and is as follows:

Name:	
All granitic rocks, granites, diorites, etc.	}
Sandstones (siliceous cement)	
Quartzites and quartz masses	
Traps (basalt) porphyries and volcanic glasses	
Conglomerates and agglomerates	
Gneisses, breccias	}
All rocks of Group I. badly weathered	}
Sandstones (lime or iron cement)	
Limestones and marbles	
Serpentines, schists, slates and argillites	
Hardpan (glacial, etc.)	
	}
Shales	}
Rubble limestone	
Loose sandstone	
Coquina	
Marls	
Travertine	}
Tuff	
Glacial till	
Silt	}
Mud	
Sand	
Gravel	
Volcanic ash (loose)	

GROUP I.  
Solid and unweathered  
rocks.

GROUP II.  
Intermediate rocks.

GROUP III.  
Soft rocks.

GROUP IV.  
Unconsolidated (earth).

As the advisability of placing slates in the same group with sandstones with lime or iron cement may be questioned, we would make it clear that in this case we realize the extreme hardness of some slates, but believe this feature is offset by considering their cleavage, which makes it easier to excavate them than other rocks not so hard.

It may also be pointed out that there is still considerable latitude in this classification, and there will be opportunities for dispute. For instance, one party to a contract will assert that a given rock is badly weathered, and the other will claim just the contrary. We do not see how all dispute can be avoided. It might be suggested here that in the case of large and important work a third neutral expert geologist be consulted and his decision agreed to by both parties before commencing work. Even

here changes will have to be made as the excavation proceeds and the formations newly uncovered are seen to change.

Copies of this proposed classification have been submitted to the Northwestern Association of Highway Engineers, and it is hoped that comments by these practical field men will be forthcoming. The writer would like to see this classification discussed in the pages of this journal, and hopes in the future, after he has digested these criticisms to revise it and again to submit it to interested engineering journals.

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