MATHEMATICS AND GEOSCIENCES

GEORGIA MOUDIOTI

May 7, 2021

1 introduction

Traditionally, the science of geology has had a relatively minimal mathematical application in comparison to other sciences such as physics, chemistry and mathematics. This trend has been because of the importance that was attached to the compositions of the different rock types, their mineralogy and consequently their relative ages in terms of the geological time scale. Basically, geology can be conveniently divided into three categories namely; the "Hard" Rock geology; the "Soft" Rock geology and the "Applied" geology. The subject matters that fall within the "Hard" Rock geology category, are Economic geology, Geochronology, Geochemistry, Petrology/Petrography, Structural geology, Mining geology, Mineral exploration, etc. Subjects that fall within the "Soft" Rock geology are: Sedimentology, Sedimentary geology, Petroleum geology, Paleontology/Pateocology, Economic geology, Organic geochemistry, Structural geology, Stratigraphy, etc It would be observed that in the grouping of the subject matters under both categories there is an unavoidable number of subjects that are common to both groups. On the other hand, the subjects that can be considered to fall within the category of "Applied" geology are; Engineering geology, Rock Mechanics, Soil mechanics, Geotechnics, Hydrogeology and Geophysics. It should be pointed out here that the subjects of Engineering geology, Rock/Soil mechanics and Geotechnics are very closely related to the disciplines of civil and mining engineering.

2 Applications of mathematics to the various branches of geoscienses

The role or importance of mathematics in each of the three categories of the geosciences will be looked into in this section of the paper. In doing this;, attention will be paid only to the relevant subject matters in each of the first two categories while the third category will receive full treatment since it is entirely made up of subjects strongly dependent on mathematical applications.

3 "Hard" Rock Geology

One of areas in which mathematics is applied in the hard rock geology category is mining geology. In every mineral exploration programme, it becomes necessary to estimate the amount of ores (that is, ore reserves) present before the mine is established. This process requires the knowledge of the lateral extent, the depth of the ore body and the variations of thickness over the extent of the deposit. Integral calculus is often employed in the determination of the volume of such ore bodies and hence the computation of such ore reserves. Even when the mine is to be developed, knowledge of the slope angles of the open-pit is required, and this is usually obtained through mathematical formulae that incorporate elements of the mine geometry and the material properties of the mine rock. In the subject of Geochronology, the ages of rocks are often determined through radio-metric dating techniques. These techniques, which utilize the half-lives and decay constants of radioactive ma-

terials, employ some mathematics. The subject of structural geology, which falls within both "Hard" and "Soft" rock domains, employs quite a bit of basic mathematics. The mathematics is involved in the computation of structural trends e.g. (fractures and lineation), dip angles, plunges, thickness of rock strata, etc.

4 "Soft" Rock Geology

The sediments that constitute the bulk of the "Soft" rocks are deposited through the activities of waves, wind, rapidly flowing currents, like water, wind among others, and as such much of the mathematics involved in this category is of the "Dynamics" type. Sedimentology is a subject in the "Soft" rock category that deals with sedimentary processes. These processes are directly related to flow velocities of streams and rivers and the rates of stream sedimentation and scour. The distance from source and other factors of a particular sedimentary deposit can be inferred mathematically from the sizes and geometries of the grains of sediments within that particular deposit. This aspect of geology is receiving a lot of attention from computer applications, due to the size of the data involved in research. Another area within the "Soft" rock geology category that has quite a bit of mathematical input is petroleum geology. Though it is of a more definite nature, it tends to be similar in many ways to petroleum engineering. Here, mathematical techniques abound in the estimation of oil reserves, mode and rate of oil flow within source rocks in a given oil field. Even the subject of micropaleontology which has traditionally been that of identification of the various fossils present in various rock types and age determinants of the various rock based on the relative ages of the fossils contained in them, has in recent years, no longer escaped the application of basic mathematics. The degrees to which the various shapes and sizes of fossils have been distorted, are now used to compute the orientation, the velocity of stream flow and the energy level of pale currents in the ancient environments in which these fossils and rock assemblages once existed.

5 "Applied" Geology

Perhaps the grates needed for mathematical application in geosciences is felt in the "applied" geology category. In engineering geology, which is basically the application to civil and mining engineering, the engineering properties of naturally occurring earth materials such as rock aggregates, gravels, etc. are critically evaluated and applied to constructions in mining and civil practices. In this, case, the emphasis is placed on the mechanics of earth materials in terms of their compressive, tensile and shears strengths. Of particular note in this critical evaluation are the forces and moments that act upon these earth materials during their use in construction and efforts made to ensure that the. superimposed forces do not exceed their natural strengths. Soil and Rock mechanics follow very closely set patterns of study in traditional or classical theories of strength of materials in steel structures, etc, in civil engineering practice. The need to introduce these courses arose from the fact that many failures were recorded in structures that was adequately designed in terms of basic structural mechanics in civil engineering practices. However, it was observed during subsequent post - mortem examination of the failed structures that little or no geological inputs were inculcated into their initial designs. The relevance of mathematics in these subjects-Rock/Soil mechanics is quite substantial to say the least. Another area in the "applied" geosciences where the input of mathematics is felt is Hydrogeology. In this case, the hydraulics of flow in both surface and underground water is studied with the aid of basic principles of mathematics. In surface water studies, both laminar and turbulent flow regimes are treated. In flow through porous media in ground water studies, the flow regime is mostly laminar while laminar and /or turbulent regimes observed in flow through fractured media. Geophysics is another area in the geosciences where mathematical applications are very relevant. In this case, the physics of the earth is treated extensively. In a nutshell it involves the mathematical treatment of the effects of gravity, magnetism radioactivity and seismcity on deeply located ores and mineral fuels in the earth's crust.

6 Conclusion

From the foregoing discussions, we can now observe that mathematics is becoming more and more relevant in the various fields of geosciences. The low-key role of mathematics in traditional geosciences such as "hard" and "soft" rock geology categories, is giving way gradually to a more rigorous mathematical approach in the relatively new "Applied" geology programme. It is hoped that before long, almost all aspects of the geosciences will involve more mathematical input in both research and teaching. This will be more than welcome, bearing in mind the present availability of micro computers at our own disposal.

7 References

References

[1] Ferguson, J.*Mathematics in Geology.Unwin HymanHLtd.*,UK, 1998

[2] Nibir, M.I. *Fow and strain patterns at the terminations of tapered shear zones.*,Structural of Geology, 2002

[3] oluwatosin, G.A. *Variability of surface properties of an ultisol as fuction of topography in sandstone landscape of south western Nigeria*,global of Journal of pure and applies scienses, 2007