RESEARCH GATE Q/A 2019:

Has biased academic and commercial marketing hidden basic problems of description and modelling of rock masses in the last several decades?

In 2003 the writer posed some questions for the ISRM journal editor. Many seem in need of repeating. A different format and some additions will be tried here.

1. Why can we monitor the progressive failure of slopes, and pillars, and over-stressed volumes underground?

2. Is it because the strength of rock masses is described by linear Mohr-Coulomb or non-linear Hoek-Brown/GSI?

3. Do such models of 'c plus sigma n tan phi' (linear or non-linear) realistically describe where shear failure is occurring around an over-stressed opening (e.g. the classic URL mine-by)?

4. Is the development of GSI ('to replace RMR') the first time we can inspect rock masses? (Recent Canadian university authors - clearly with journal reviewer's and co-author acceptance - described GSI as follows: 'After decades of relying on empirical classification systems to assess rockmass quality and ground support prescriptions, a rockmass characterization system that depends on direct geological field observations was created: the Geological Strength Index GSI').

5. Do we / did we perform 'direct geological field observation' when using the Q-system and RMR (in the last 45 years)?

6. Is GSI more 'geological' or 'observational' than RMR or Q?

7. Do any other serious scientific professions combine picture recognition and multiple opaque equations to estimate their key parameters?

8. What happens to the H-B c, φ, 'compressive' strength, and deformation modulus if there was one more joint set and this had clay filling?

9. We can monitor the progressive failure of over-stressed slopes, pillars, mine-volumes because rock masses *do not fail* by exceeding the addition of cohesional and frictional strength.

10. We can model where shear failure is occurring *by not adding* cohesion and friction, but rather by degrading cohesion and mobilizing frictional strength, up to peak and down towards residual.

11. Rock masses reach ultimate failure after exceeding the strength of (maybe) four components, each mobilised at different shear strains or displacements.

12. The components are (probably but not always) failure of intact rock (clearly includes stock-work and welded veins: they reduce the representative UCS), shearing of the new fractures, shearing of appropriately oriented joints, and maybe shearing of the lower resistance filled discontinuities (which often form one side of a large instability).

13. If one was able to be present without getting killed it might be heard as CCSS: crack, crunch, scrape, swoosh. (One may smile, but this is seriously meant).

14. It is more than 50 years since Müller, 1966 (and Rocha) regretted that we did not know how to formulate the shear strength of rock masses. Müller suggested, as here, and as done by several colleagues in the last two decades, that after cohesion was broken friction remained. *'The deformation resistance of the material bridges takes effect at much smaller deformations than the joint friction: this joint friction makes partly up for lost strength'*.

15. We should *not* be adding c and σ_n tan φ.

16. Recently the writer has demonstrated that cliffs or mountain walls in massive rock do not have heights limited by Coulomb (c and φ). These parameters over-estimate heights by factors of 3 to 6 times (lower and upper-bound soil-based solutions for vertical cuts). But tensile strength, Poisson's ratio (and density) give correct results – from 10m to 1,000m.

Apparently Leonardo da Vinci (1452-1519) once gave advice that was distinctly helpful to one starting out in a relatively undeveloped field: 'If you find from your own experience that something is a fact and it contradicts what some authority has written, then you must abandon the authority and base your reasoning on your own findings'. Let's start over and make progress in the next 50 years.