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# Characterising rock fracture aperture-spacing relationships using power-law relationships: some considerations

Martin Brook, Bruce Hebblewhite, and Rudrajit Mitra
School of Mining Engineering, University of New South Wales, Sydney, Australia

The size-scaling of rock fractures is a well-studied problem in geology, especially for permeability quantification. The intensity of fractures may control the economic exploitation of fractured reservoirs because fracture intensity describes the abundance of fractures potentially available for fluid flow. Moreover, in geotechnical engineering, fractures are important for parameterisation of stress models and excavation design. As fracture data is often collected from widely-spaced boreholes where core recovery is often incomplete, accurate interpretation and representation of fracture aperture-frequency relationships from sparse datasets is important. Fracture intensity is the number of fractures encountered per unit length along a sample scanline oriented perpendicular to the fractures in a set. Cumulative frequency of fractures $(F)$ is commonly related to fracture aperture $(A)$ in the form of a power-law ($F = aA^{-b}$), with variations in the size of the $a$ coefficient between sites interpreted to equate to fracture frequency for a given aperture $(A)$. However, a common flaw in this approach is that even a small change in $b$ can have a large effect on the response of the fracture frequency $(F)$ parameter. We compare fracture data from the Late Permian Rangal Coal Measures from Australia's Bowen Basin, with fracture data from Jurassic carbonates from the Sierra Madre Oriental, northeastern Mexico. Both power-law coefficient $a$ and exponent $b$ control the fracture aperture-frequency relationship in conjunction with each other; that is, power-laws with relatively low $a$ coefficients have relatively high $b$ exponents and vice versa. Hence, any comparison of different power-laws must take both $a$ and $b$ into consideration. The corollary is that different sedimentary beds in the Sierra Madre carbonates do not show $\sim 8\times$ the fracture frequency for a given fracture aperture, as based solely on the comparison of coefficient $a$. Rather, power-law "sensitivity factors" developed from both Sierra Madre and the Bowen Basin span similar ranges, indicating that the factor of increase in frequency $(F)$ for a doubling of aperture size $(A)$ shows similar relationships and variability from both sites. Despite their limitations, we conclude that fracture aperture-frequency power-law relationships are valid and, when interpreted carefully, provide a useful basis for comparing rock fracture distributions across different sites.