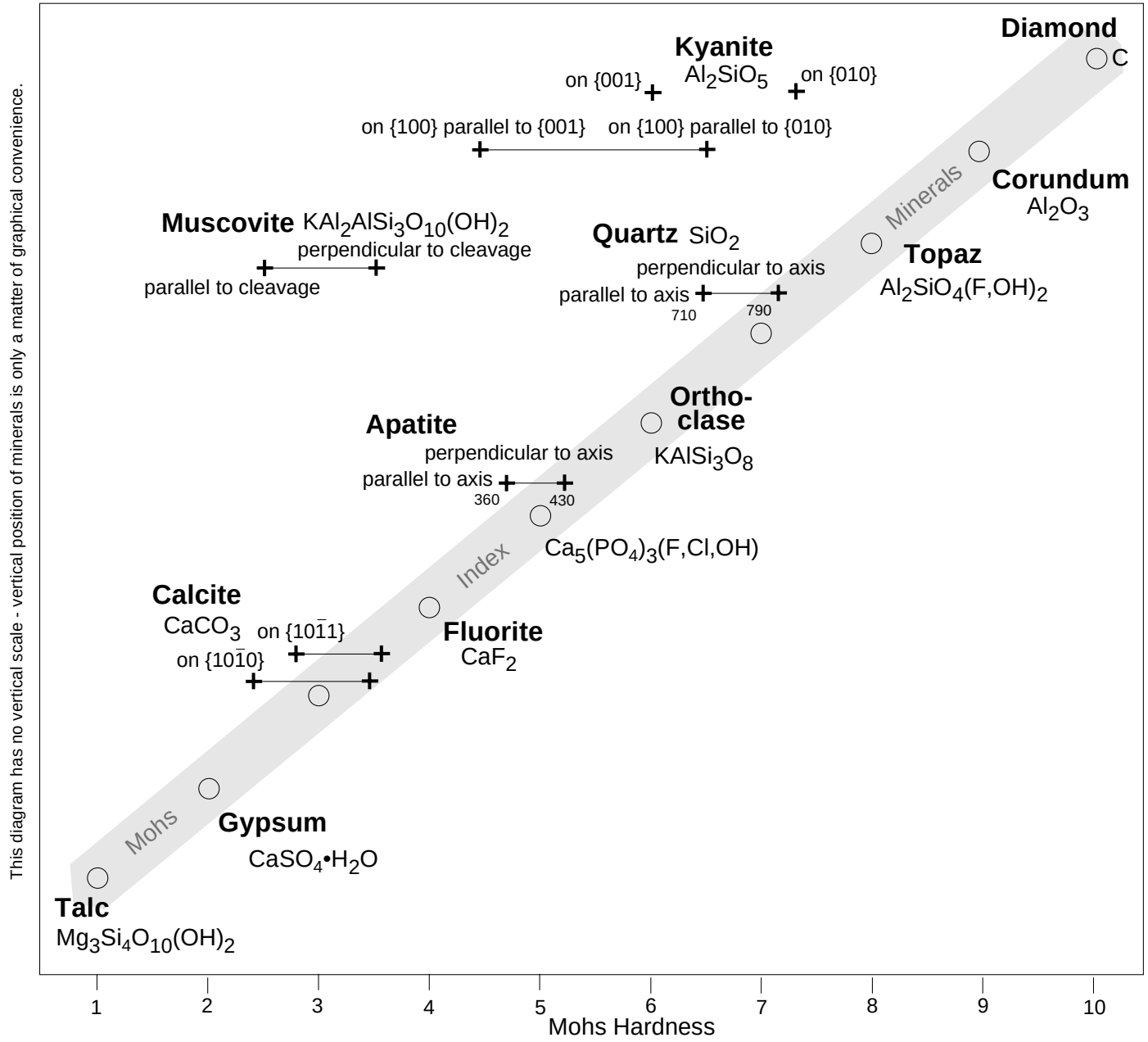
Hardness of minerals VI: effect of crystal face and direction



Simple discussions of hardness of minerals assume that any mineral has one value of hardness. In fact, in many minerals hardness varies from crystal face to crystal face, and it also commonly varies with direction on any one crystal face. Hardness in therefore said to be "anisotropic", or to vary with direction relative to the crystal structure. This dependence of hardness on orientation is to be expected if one appreciates that hardness is measured by deformation (scratching or indentation) of the crystal structure via the breakage of bonds, and that different surfaces intersect the crystal structure at different orientations, subjecting different bonds, and different frequencies of bonds, to breakage.

One of the most strking examples of this effect is kyanite, where hardness varies across several units of the Mohs scale. Significant variation also exists within quartz, apatite, and calcite, three index minerals of the Mohs scale. Thus defining integer values of Mohs hardness by the hardness of a particular mineral is problematic, because at least some of those minerals, and probably all of them, have hardnesses that vary.

Sources:

Knoop, F., Peters, C.G., and Emerson, W.B., 1939, A sensitive pyramidal-diamond tool for indentation measurements: *Journal of Research of the National Bureau of Standards*, v. 23, p. 39-61 (see esp. Table 8).

Gaines, R.V., et al., 1997, *Dana's New Mineralogy:* New York, John Wiley & Sons, 1819 p.

von Tertsch, H., 1950, Beobachtungen über Vickers-microhärte am kalkspat: *Mikroskopie: Zentralblatt für Mikroskopische Forschung und Methodik,* v. 5, p. 172-183. Depiction of von Tertsch's data here is best considered qualitative, because the quantitative data reported defy simple transfer to this diagram.