ABSTRACT

In this study, anisotropy of magnetic susceptibility (AMS) measurements were made on massive quartzites that lack visible foliations. Using AMS data, the magnetic foliation was recognized in the quartzites. Ultrasonic P-wave velocity (V_p) and corrected point load strength ($I_{s(50)}$, which is a proxy for uniaxial compressive strength) were determined in cores drilled parallel as well as perpendicular to the magnetic foliation. V_p is greater in the direction parallel to magnetic foliation than perpendicular to it. $I_{s(50)}$ is lower in the direction parallel to magnetic foliation than perpendicular to it. It is noted that quartzites with a strong magnetic fabric also have a high P-wave velocity anisotropy as well as rock strength anisotropy. Based on these results, it is concluded that AMS can be used to identify principal testing directions for rock mechanics investigations in massive rocks that lack visible foliations.

To evaluate the role of microfabric and microcracks in controlling the above anisotropies, a comprehensive microstructural investigation involving petrography, scanning electron microscopy and fractal analysis was carried out. It is noted that the shape of the magnetic susceptibility and strain ellipsoids are correlatable. It is shown that the mica grains that form the minor phase in the quartzites control the evolution of quartz fabric in the rocks. Most of the microcracks in the experimentally untested quartzites are grain boundary microcracks. These show fractal behaviour. In experimentally deformed samples, a more chaotic microcrack network and a marginally higher box (fractal) dimension are noted in sections perpendicular to the loading direction than in sections parallel to the loading direction as well as the different sections of the untested sample. Microcrack anisotropy quantification using the program AMOCADO (based on Cantor Dust method) in loading perpendicular sections is less, which is attributed to the generation/growth of new cracks in different directions. Thus the present study enhances understanding of (a) usefulness of AMS in rock mechanics, (b) control of the minor phase on fabric evolution of major mineral phase, and hence its anisotropy evolution, and (c) microcrack evolution with reference to loading in point load tests.

Key words: Fabric analysis, anisotropy quantification, quartzite, structural geology, rock mechanics, fractal