geoconvention
Virtual Event
September 21-23
2020
CSPG • CSEG • CWLS • GAC • MAC • IAH

Fracture systems in the Perdrix Formation and Devonian carbonates, Roche Miette, Jasper National Park: evidences of thrust-related deformation and implications for fluid migration

Elena Konstantinovskaya and Atena Bahramiyarahmadi
University of Alberta

Summary

We analyze fracture orientation and distribution in Devonian sedimentary succession of the Miette syncline above the Miette Thrust (Roche Miette, Jasper National Park) to evaluate the effect of fractures on subsurface fluid migration. This study is carried out based on outcrop measurements and mapping using orthomosaic maps built from a drone survey.

Devonian sedimentary succession of the Miette syncline is considered to be stratigraphically continuous with bedding steeply dipping to the SSW on the NE limb of the fold and flattening to subhorizontal position in its axial part (Mountjoy, 1983; Patterson, 1955). However, our field study reveals the presence of small-scale duplexes in thick limestone beds of the Southesk Fm (Fig. 1) that accommodate minor horizontal displacements along the boundary between massive carbonates and the shale section below. Thrusts are rooting in the underlying layered unit of argillaceous limestone and shales of the Mount Hawk Fm. Shales of the Perdrix Fm also contain shear zones with high-density bedding-parallel calcite veins and small-scale duplexes (Fig. 2) that accommodated the shortening. Striation in shales and mineral fibers in bedding-parallel veins plunge to the SSW. Sub-vertical calcite veins overprint the horizontal ones (Fig. 2) and likely result from local extension associated with shortening.

Fig. 1. Small-scale duplexes in massive carbonates of the Southesk Fm, Roche Miette, Jasper National Park.

Fig. 2. Shortening-related bedding-parallel calcite veins overprinted by sub-vertical extensional veins in shear zones in shales of the Perdrix Fm, Roche Miette.

Different sets of veins and open fractures characterize the Devonian massive carbonates located above and below shales of the Perdrix and Mount Hawk Fms. Horizontal bedding-parallel calcite veins in the Southesk Fm are laterally extended and contain relatively large (~ 4 cm) voids with quartz druse lining. Two sets of open vertical fractures perpendicular to bedding crosscut horizontal veins. Open fractures of a dominant set are vertically extended, closely spaced (1-1.5 m) and oriented NE-SW, parallel to the shortening orientation. A set of shorter open fractures is characterized by lesser fracture density and develop perpendicular to the NE-SW fractures.

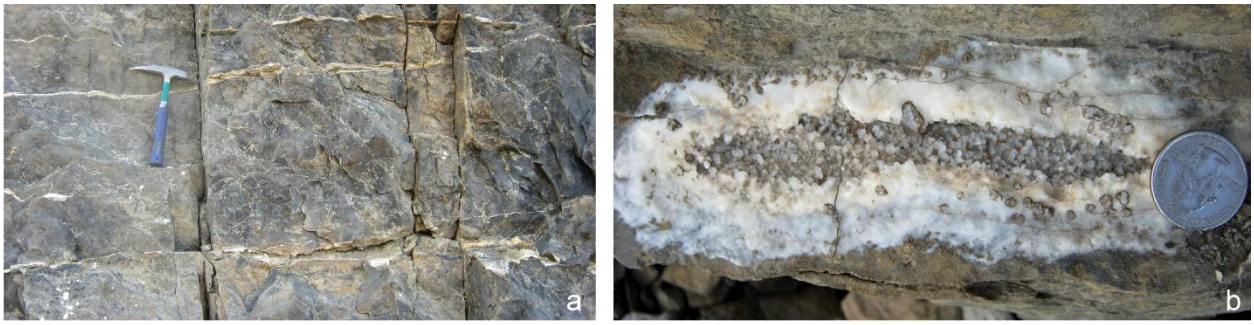

Fig. 3. The set of vertical open fractures and horizontal calcite veins (a) and voids with quartz druse in horizontal calcite veins, view from the top (b), Southesk Fm, Roche Miette.

Bedding-parallel calcite veins in shear zones in shales of the Perdrix Fm and in overlying carbonates are likely related to an early phase of the NE-SW shortening and served as paths for fluid migration. The system of open bedding-perpendicular fractures in massive carbonate beds formed afterward during a major phase of folding. The studied fracture systems and deformation phases of the Roche Miette area are relevant in interpreting natural fractures and fluid migration in the subsurface Duvernay and Ireton Formations of the Fox Creek area.

Acknowledgements

We are grateful to D. Zubot, Z-Air for an excellent drone survey; Jasper National Park and Parks Canada for special permits for conducting the drone survey, research study and sample collection. This work was funded by NSERC (Natural Science and Engineering Research Council of Canada) through grant NSERC-RGPIN-2019-04397 and the Environment Geoscience Program, Lands and Minerals Sector, Natural Resources Canada.

References

Mountjoy, E.W., 1983. Miette, Alberta. Natural Resources Canada. Map 2158A.
Patterson, A.M., 1955. The Devonian of Jasper Park. Guide 5th Annual Field Conf. Jasper National Park: 117-127.