Presented at the 65th Annual Institute on Lake Superior Geology
May 2019, Terrace Bay, Ontario

Hyperspectral Imaging of Bedrock Core from the Minnesota DNR Drill Core Library: A New Tool for Archival Preservation and Mineral Exploration

ELSENHEIMER, Don[1], DEYELL-WURST, Cari[2], and FONTENEAU, Lionel C.[3]
[1]Minnesota Department of Natural Resources, 500 Lafayette Rd, St. Paul, MN 55155 USA
[2]Corescan Pty Ltd, 22033 Boul Gouin Ouest, Montreal, QC, CANADA
[3]Corescan Pty Ltd, 1/127 Grandstand Road, Ascot WA 6104, AUSTRALIA

The Minnesota Department of Natural Resources (DNR) hired Corescan Inc. to scan 4900m of bedrock core from the DNR Drill Core Library (DCL) using Corescan's hyperspectral core imaging system (Martini et al, 2017). The technique integrates both Visible Near InfraRed (VNIR) and Shortwave Infrared (SWIR) reflectance spectroscopy with high-resolution photography (50 μm) and 3-d laser profiling (200 μm) to identify minerals, estimate mineral abundances and create textural maps at 500 μm resolution. Hyperspectral imaging is a non-destructive analytical technique that supports the archival preservation of limited core material. Project results support DNR land management decisions on state mineral rights and promote mineral exploration and development. This project for the first time will provide public access to hyperspectral imaging data archived within the Coreshed® Virtual Core Library. DNR anticipates public release of project data and public access to Coreshed by summer, 2019.

The DNR selected project core from thirty-two (32) drill holes located in five areas in Northern and Central Minnesota with distinct mineral deposits and/or high mineral potential. Initial project results are from an Archean Wabigoon Subprovince greenstone terrane near International Falls (Seine Group) and Biwabik Iron Formation core from the Mesabi Range.

The Seine Group of greenschist-facies, metasedimentary and metavolcanic rocks sits at the contact between the Wabigoon and Quetico Subprovinces of the Archean Superior Province (Jirsa et al., 2014). Gold exploration in the region included an active period of drilling in the late 1980's. Frey (2012) re-logged and re-sampled several of the DCL-archived Seine Group cores, and identified alteration patterns and features favorable for gold mineralization, including greater abundances of porphyoblastic and vein tourmaline. Hyperspectral imaging of twelve archived DCL cores from the area extends Frey's tourmaline observations to drill cores that (due to active exploration) were not available at the time of his study. There is a positive correlation between gold concentrations and hyperspectral mineral identification of under-recognized tourmaline. Variations in the 2350nm feature position (Bierwirth, 2008) suggest tourmaline compositions within the dravite-schorl series *(Figure 1).*

Complete or near complete transects of the Biwabik Iron Formation (BIF) were imaged in six Mesabi Range drill cores (LWD99-1, LWD99-2, MDDP-2, -5, -7, and -8). Hyperspectral imaging of core from LWD99-2 is able to differentiate microplaty hematite banding from more martite-rich bands. Two chlorite types are also recognized within this same core based on absorption features; an Mg-Fe intermediate composition that occurs in the Virginia Formation and its contact with the underlying Upper Slaty Unit, and a more iron-rich chamosite found in the Lower Cherty Unit and its contact with the underlying Pokegama Quartzite.

Average albedo in the visible spectral range (448-740nm) highlights variation within the heavily sampled contact between the BIF and overlying Virginia Formation, where Addison et al. (2005) identified an ~25 to ~58cm thick ejecta layer associated with the 1850Ma Sudbury impact event. White mica is recognized based on absorption features within an ~ 2.6m interval of LWD99-2 core at the transition from BIF to Virginia Formation. Within this occurrence interval, a much smaller ~ 38cm interval with ammonium-rich white mica (feature around 2010nm, Canet et al. (2015)) is recognized in a thin layer of cherty carbonate. The discovery of relatively rare ammonium-rich white mica in association with an identified ejecta layer, if confirmed, would be significant.

References

Addison W.D., Brumpton G.R., Vallini D.A., McNaughton N.J., Davis D.W., Kissin S.A., Fralick P.W., and Hammond A.L. (2005) Discovery of distal ejecta from the 1850 Ma Sudbury impact event. Geology 33:193-196.

Bierwirth, P.N. (2008) Laboratory and imaging spectroscopy of tourmaline - a tool for mineral exploration. 14th Australasian Remote Sensing and Photogrammetry Conference, Darwin.

Canet C., Hernández-Cruz B., Jiménez-Franco A., Pi T., Peláez B., Villanueva-Estrada R.E., Alfonso P., González-Partida E., Salinas S. (2015) Combining ammonium mapping and short-wave infrared (SWIR) reflectance spectroscopy to constrain a model of hydrothermal alteration for the Acoculco geothermal zone, Eastern Mexico. Geothermics 53:154-65.

Frey B.A. (2012) International Falls Drill Core Descriptions and Chemistry, Koochiching County, Minnesota. Project 378 Open-File Report, Minnesota Department of Natural Resources, Division of Lands and Minerals, 39p.

Jirsa M.A., Boerboom T.J., and Chandler V.W. (2014) M-197 Bedrock Geology of the International Falls and LittleFork 30'x60' Quadrangles, northern Minnesota. Minnesota Geological Survey, Retrieved from the University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/166157.

Martini B.A., Harris A.C., Carey R., Goodey N., Honey F., and Tufilli N. (2017) Automated Hyperspectral Core Imaging – A Revolutionary New Tool for Exploration, Mining and Research. *in* "Proceedings of Exploration 17: Sixth Decennial International Conference on Mineral Exploration" edited by V. Tschirhart V. and M.D. Thomas, p. 911-922.

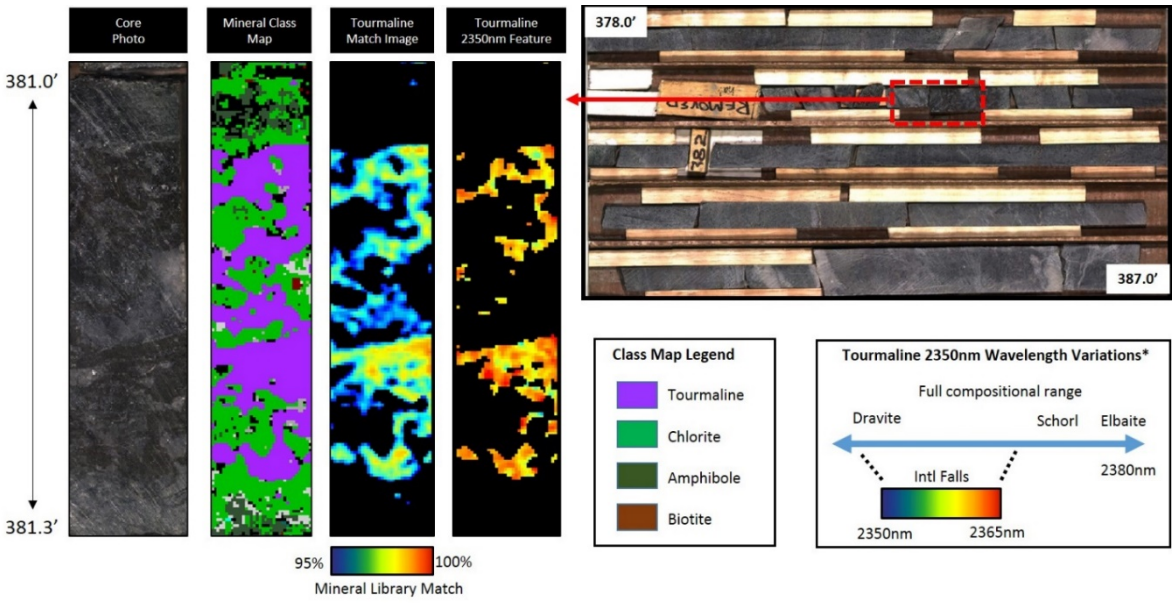

Figure 1: Hyperspectral imaging of tourmaline within an 8cm-long section of quarter-core from DDH TC35-1. This section is within a larger 4 foot (1.22m) core interval that assayed at 4020ppb Au. Variations in the 2350nm feature position (Bierwirth, 2008) suggest compositions within the dravite-schorl series.