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INTRODUCTION

The poster presents the results of field work carried out in July 2013 for the Geological Survey of Canada's Arctic Gossans Activity. The poster was presented at the Annual Meeting of the Geological Society of America held in Denver, Colorado, USA, on September 27, 2013 (Kingsbury et al., 2013).

The report describes each section of the poster. The list of references includes publications cited in both the poster and report.

BACKGROUND INFORMATION

Gossans consist of highly weathered, Fe-rich soils overlying sulphide-rich materials that can be used as exploration targets for base metal deposits. The Arctic Gossans activity was approved in 2011 as a proof of concept to investigate the fate of toxic metals in a permafrost environment. The 3-year activity was funded by the Environmental Impact Assessment project (Northern Environment) of the Environmental Geoscience Program[1]. Field work on gossans located in central Victoria Island, Northwest Territories, confirmed the underpinning scientific hypothesis:

Arctic gossans constitute analogs of how mine waste will behave in a permafrost environment. They are natural laboratories that record the processes leading to potentially acid-generating mine tailings and mine waste rock in a permafrost environment, such as mineralogical occurrences; metal recycling; deposition, sorting and burial; oxidation rates; distribution and effect of ice lenses; seepage flow-paths; etc.

Gossans that react with the permafrost environment are a rare occurrence on Victoria Island. The 2011 field team mapped and sampled gossans at two localities (Peterson et al., 2012; Williamson et al., 2012). Mineralogical studies showed that evaporite beds in the sedimentary succession contribute to the formation of gossans and that their origin is complex (Williamson et al., 2013). However, the databases collected on Victoria Island provided only partial information to propose a genetic model. This is because the environment is *static* - the acid permafrost containing pyrite sands at Gossan Hill, for example, has been preserved in this state since the last glaciation but the acid generation process is poorly understood (Peterson et al., in press).

On Axel Heiberg Island, the environment is *dynamic*: evaporite diapirs intruding the Mesozoic succession of the Sverdrup Basin show evidence of rising since the last glaciation (Zentilli et al., 2006; Jackson and Harrison, 2006; Harrison and Jackson, 2010). There are dozens of perennial springs and gossans or alteration zones associated with evaporite domes in the Strand Fiord-Expedition Fiord area (e.g. Battler et al., 2013; Williamson et al., 2011). The rationale for a field campaign in the final year of the activity was based on the necessity to document real-time, measurable geologic events that could be the cause of the formation of gossans encased in acidic permafrost on Victoria Island and Axel Heiberg Island. In both areas, the host rocks consist of continental flood basalts and associated intrusive rocks. As a result, a better understanding of the origin and evolution of gossans in such environments also carries important implications for Ni-Cu-PGE prospectivity (Bédard et al., 2012; Williamson et al., 2014; Jowitt et al., 2014).

[1] http://www.nrcan.gc.ca/earth-sciences/about/current-program/environmental-geoscience/11989

POSTER CONTENTS

Remote Predictive Mapping

The small size of most gossans (15 m to less than 1 km in length) requires careful search and analysis through remote predictive mapping (RPM) prior to any field work. RPM reduces the risk and cost of field work in remote areas of Canada's North by enabling the detailed planning of foot traverses in geologically complex areas (Harris, 2008; Harris et al., 2012). As was the case for central Victoria Island, the volcanic terrain on Axel Heiberg Island was ideal for conducting a remote predictive mapping exercise to detect and map gossans using various optical imagery (Behnia et al., 2012). The results of the RPM exercise are pertinent to spectral reflectance studies (Froome et al., 2012) and provide a tool for the selection of earth observation data that could reveal the presence of gossans in advance of field mapping.

Igneous Rocks

The poster highlights mafic igneous rocks that were mapped and sampled in the study area as part of a PhD thesis project carried out at Carleton University (Kingsbury, 2013). The objectives were to (1) document the style of eruption in the Early Cretaceous Isachsen Formation, and compare the results with previous work in other parts of Axel Heiberg Island, and Ellef Ringnes Island in particular; (2) conduct geochemical and geochronological studies; and (3) compare the results with previous work on mafic rocks from the circum-arctic High Arctic Large Igneous Province (HALIP). Important discoveries made during bedrock mapping included the complex field relationships between volcanic rocks, sills and dykes in the Isachsen Formation; and evidence for the presence of ultramafic sills.

Gossans

The poster highlights three types of gossans that were mapped and sampled in the study area: (1) a gossan associated with volcanic and sedimentary rocks in the Isachsen Formation; (2) a gossan associated with sill emplacement that is comparable to one of the gossans investigated on Victoria Island (Williamson et al., 2014); and (3) gossans closely associated with evaporite diapirs. Two of the three types of gossans displayed reactive zones with permafrost but in all case the stratigraphy is complex, and the soils, acidic. Field relationships provided important clues on the origin of gossans associated with mafic sills rafted in evaporite diapirs.

Stream Sediments

The stream sediment study on Axel Heiberg Island represents a benchmark survey for future research and exploration concept development in this area. Two types of studies were carried out: (1) a detailed study was aimed at evaluating the downstream dispersion of a known gossan; (2) a regional survey of the area provided new stream-sediment and water geochemistry coverage to yield indicator mineral samples for the evaluation of the region's bedrock geology and mineral potential.

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