PRES2009-26

GEOSCIENTIFIC PRESENTATION

Geoscientific Presentation PRES2009-26
Drift Exploration in Manitoba: short course presentations given at the Manitoba Mining and Minerals Convention
Thursday, November 19, 2009

The Short Course presentations cover drift exploration principles and methods as well as examples for a variety of commodities including base and precious metals, uranium and diamonds in glaciated terrains in Manitoba. Topics include indicator-mineral methods in mineral exploration, glacial processes, ice flow and dispersal trains, surficial sediment types, sampling and sample processing methods, and remote predictive mapping applications, all backed by case studies from Manitoba.

Presentations were given at the Manitoba Mining and Minerals Convention, November 19, 2009 and were published with permission and as provided by the authors.

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Indicator mineral methods in mineral exploration
Harvey Thorleifson *(Minnesota Geological Survey)*

Glacial processes, ice flow indicators and remote predictive mapping applications to drift prospecting
Roger Paulen *(Geological Survey of Canada)*

Useful Ni-Cu-PGE versus kimberlite indicator minerals in surficial sediments: similarities and differences
Stuart Averill *(Overburden Drilling Management Limited)*

Till indicator mineral and geochemical signatures of magmatic Ni-Cu deposits, Thompson Nickel Belt
Beth McClenaghan *(Geological Survey of Canada)*

Drift prospecting for uranium: emphasis on Athabasca Basin, Saskatchewan
Janet E. Campbell *(Geological Survey of Canada)*

Post-glacial lake sediments as an aid to base metal and uranium exploration in northern Manitoba
Martin W. McCurdy *(Geological Survey of Canada)*

ABSTRACT:

Indicator mineral methods in mineral exploration
H. Thorleifson *(Minnesota Geological Survey)*

In recent years, the application and effectiveness of indicator mineral methods in mineral exploration has been steadily increasing, and their scope has been expanding from well-established procedures, such as those for gold grains and kimberlite indicator minerals, to new approaches for targets such as base metals. These methods, which rely on mineral grains suggestive of a possible mineral deposit in the rocks from which they were derived, are based on sampling of sediments such as glacial and stream sediments and detection of mineral deposit indicators dispersed by mechanical processes. These approaches are part of a spectrum of clastic sediment-based methods ranging from boulder tracing to detection of detrital debris or their weathering products by chemical analysis of C-horizon soils and sediments.

BIOGRAPHY:

Harvey Thorleifson is Director of the Minnesota Geological Survey, State Geologist of Minnesota, and Professor in the Department of Geology and Geophysics at the University of Minnesota. He serves on the Executive of the Association of American State Geologists, and was the 2004-2006 President of the Canadian Federation of Earth Sciences, and he was the 2003-2004 President of the Geological Association of Canada. He holds Bachelor's degrees from the University of Winnipeg, a Master's degree from the University of Manitoba, and a Ph.D. in geology from the University of Colorado. While with the Geological Survey of Canada from 1986 until 2003, he worked in a broad range of soil and water-related fields, including much activity in the use of indicator mineral methods in mineral exploration.

ABSTRACT:

Glacial processes, ice flow indicators and remote predictive mapping applications to drift prospecting

R. Paulen *(Geological Survey of Canada)*

Effective diamond and mineral exploration in glaciated terrain calls for a thorough knowledge of the glacial geology of the area concerned. Over the last two decades the basis for drift prospecting in Canada has significantly improved through the continued development of ice sheets models, the acquisition of empirical evidence for ice flow, drift composition and glacial history through an improved understanding of glacial processes. Particular attention has been paid to the nature and evolution of ice sheet growth, ice divide migration and ice streaming during deglaciation. Understanding the erosional and depositional records of ice flow is critical. The type, definition, provenance and relative age of the geological record, including streamlined landforms, reflect their geographic and glaciological context in the former ice sheet, and they cannot be weighed equally for the interpretation of glacial dispersal patterns. The intent of this lecture is to succinctly highlight processes and features specific to glacial materials derived, transported and deposited within western Canada. The message for exploration is that relations among bedrock, drift composition and ice flow history must be inferred in the wider context of the ice sheet and glacial history through recognition of the distinct character of the erosional and depositional records.

BIOGRAPHY:

Roger Paulen recently joined the Geological Survey of Canada as a Research Scientist in 2008. Prior to joining the GSC, he had worked on a number of projects in northern Alberta and the central interior of British Columbia for their respective provincial surveys since 1997. He holds a Bachelor's degree from Mount Allison University, a Master's degree from the University of Waterloo, and a Ph.D. in progress at the University of Victoria. Roger has conducted surficial mapping and drift prospecting research in the Canadian Shield (Arctic and Boreal environments), Canadian Cordillera and Western Canada Sedimentary Basin. He is the lead editor for a GAC volume on drift prospecting in western and northern Canada, to be published in 2010.

ABSTRACT:

Useful Ni-Cu-PGE versus kimberlite indicator minerals in surficial sediments: similarities and differences

S. Averill *(Overburden Drilling Management Limited)*

Most Ni-Cu-PGE-fertile intrusions originate from partial melting of peridotite layers in the upper mantle. These source peridotites are similar to those from which indicator minerals grains are physically harvested by kimberlite melts ascending from greater depths. During subsequent crystallization of the Ni-Cu-PGE-fertile melts in the crust, a diverse suite of potentially useful indicator minerals is produced, some of which have counterparts in the kimberlite indicator mineral suite reflecting their original mantle peridotite connection. Nearly 20 heavy minerals have proven useful as Ni-Cu-PGE indicator minerals in weathered surficial sediments samples collected in diverse climatic regions. These minerals are divisible into three suites that variously provide evidence of initial melt fertility and subsequent localized sequestration of Ni-Cu-PGE sulphides from the melt: (1) cumulus Mg and Cr-rich minerals; (2) hybrid felsic-mafic minerals produced by assimilation of felsic country rocks by the mafic melt; and (3) actual Ni-Cu-PGE bearing minerals. The four main cumulus indicator minerals, forsterite, enstatite, Cr-diopside and chromite, all have kimberlitic counterparts but are distinguishable from them on the basis of colour, surface texture and grain size. Of the actual ore minerals, Fe and Ni sulphides and Pt and Pd sulphides and tellurides are all very unstable in weathered surficial sediments but chalcopyrite and Pt, Pd and FeNi arsenides and antimonides are sufficiently stable to be used as Ni-Cu-PGE indicators. The presence of even a few PGE-bearing grains normally indicates close proximity to mineralization. Several Ni-Cu-PGE indicator mineral dispersal trains have been defined in Canada. Cryptocrystalline Cr-andradite garnet, a hybrid indicator mineral, forms a unique train in till at Lac des Iles. Regional-scale trains >100 km long – similar in size to those from major kimberlite fields – are associated with the Thompson Ni Belt, the Timmins komatiites and the Ring of Fire chromitites.

BIOGRAPHY:

Stu obtained his B.Sc. Honours in Geology from the University of Manitoba in1969. He is President of Overburden Drilling Management Limited, an industry-leading heavy mineral processing and consulting business that he founded in 1974, and also currently serves as Vice-President Exploration of Rainy River Resources Ltd. Stu is a registered Professional Geoscientist in both Ontario and Newfoundland and an active member of the Association of Applied Geochemists and several other industry associations. He is dedicated to indicator mineral research and exploration and is credited with many technical advancements in these fields and with several significant mineral deposit discoveries. In 2003, he received the PDAC's Distinguished Services Award in recognition of these achievements.

ABSTRACT:

Till indicator mineral and geochemical signatures of magmatic Ni-Cu deposits, Thompson Nickel Belt

M.B. McClenaghan *(Geological Survey of Canada)*, S.A. Averill *(Overburden Drilling Management Ltd.)*, I.M. Kjarsgaard *(Consultant)*, D. Layton-Matthews *(Queen's University)* and G. Matile *(Manitoba Geological Survey)*

The Geological Survey of Canada conducted a study around the ultramafic-associated Ni-Cu deposits in the northern Thompson Nickel Belt, Manitoba, Canada to document the indicator mineral and geochemical signatures of the deposits in till. Samples used in this study include archived till collected in 1996 and till and bedrock samples collected in 2005 and 2006. Ni-Cu mineralization indicator minerals identified in the study include pentlandite, pyrrhotite, sperrylite, chalcopyrite, pyrite, millerite and arsenopyrite. Indicators of potentially fertile ultramafic intrusions include chromite, Cr-diopside, forsterite, enstatite and Cr-corundum. Till geochemical pathfinder elements identified and reported in GSC Open File 6005 include Ni, Cu, Pd, Pt, Co, As, Cd, Ag, Sb, Bi, Se, S, and Te. Six anomalous till samples from remote locations outside the Belt contain significant elevated concentrations of pathfinder elements and warrant further investigation. The Laurentide Ice Sheet flowed SW across the belt and subsequently W and exploration along the belt and in the surrounding terranes should consider both the older southwest and younger westward ice flow events when interpreting and following up till mineralogical and geochemical results.

BIOGRAPHY:

Beth McClenaghan is a graduate of the University of Waterloo and Queen's University and is a research scientist at the Geological Survey of Canada, where she has worked for the past 18 years. Her research has focused on methods development for till geochemistry and indicator minerals and soil selective leaches applied to mineral exploration in glaciated terrain, with particular emphasis on gold, diamonds and, in the past 5 years, base metal deposits. Beth is currently Editor of the Association of Applied Geochemists EXPLORE newsletter.

ABSTRACT:

Drift prospecting for uranium: emphasis on Athabasca Basin, Saskatchewan
J.E. Campbell *(Geological Survey of Canada)*

The challenge for geochemical exploration for unconformity-type uranium deposits in the Athabasca Basin, Saskatchewan, is the lack of bedrock exposure (typically<5%) and extensive cover of thick glacial sediments (>5m). The applicability of drift prospecting, and the choice of technique(s) and approach, are dependent on the thickness of the sandstone cover, the expected type of alteration (silicification vs desilicification, clay minerals), type of mineralization (ingress vs egress), the Quaternary geological conditions (surficial geology, thickness and stratigraphy), and till composition and provenance. The optimum regions for uranium drift prospecting are where both the sandstone and overburden cover is thin and locally derived. Current surficial geochemical exploration techniques primarily focus on the recognition of the enrichment halos in surface sandstone boulders. These sample medium works well if the deposit is silicified. Certain alteration styles, such as quartz dissolution, result in incompetent sandstone which does not survive glacial transport as boulders. In such areas, the application of till matrix geochemistry and mineralogy techniques for detection of glacially dispersed alteration and geochemical enrichment halos is more appropriate. Till composition is variable, reflecting differing proportions of Canadian Shield crystalline rock versus Athabasca sandstone detritus in the till. Normalization of the geochemical data for any size fraction of the matrix by NaO2 or CaO accentuates the sandstone component of the till for that size fraction. The optimum fraction to analyses for uranium is the clay-size fraction. An integrated approach involving radiometric data, bedrock and Quaternary geology, and till composition data (chemical, mineralogical, and lithological) and provenance is recommended for a successful surficial geochemical sampling program.

BIOGRAPHY:

Janet received her MSc. in Geology (fluvial sedimentology) in 1988 from the University of Saskatchewan. She recently joined the GSC Ottawa in the fall of 2009, as a Research Scientist in Quaternary Geoscience, Northern Canada Division. Prior to joining the GSC, Janet worked for 27 years as a Quaternary geologist in the Prairie Provinces with the Saskatchewan Research Council, Alberta Geological Survey and most recently, the Saskatchewan Geological Survey. Her work in the northern Saskatchewan focussed primarily on mineral exploration involving regional surficial mapping and ice-flow reconstruction, till geochemistry and indicator mineral surveys, and development of drift prospecting techniques for a variety of commodities ranging from precious metals to uranium. Her years of field work on the Athabasca Basin have gained her recognition as an expert in uranium drift prospecting techniques.

ABSTRACT:

Post-glacial lake sediments as an aid to base metal and uranium exploration in northern Manitoba

M.W. McCurdy *(Geological Survey of Canada)*

Between 1976 and 1991 over 18,000 sediment samples were collected and analyzed from lakes throughout the Churchill and Superior geological provinces in northern Manitoba, representing an area of approximately 215,000 km^2. These samples are stored at an archive in Ottawa. Reanalysis of these samples by current commercially available analytical methods have the potential to reveal new areas for U and base metal exploration. Interpretation of lake sediment data is based on the premise that element values of centre-lake sediments reflect the chemistry of underlying or adjacent bedrock, as well as dispersal patterns in surrounding surficial materials deposited by complex glacial processes. Lake sediments in northern Manitoba consist of about 40% organic gels and organic sediments, and about 60% inorganic sediments derived from surficial materials and bedrock. Factors such as rock type, topography, partitioning and glacial history affect the composition of lake sediments. Thick deposits of laminated silt/clay deposited during glacial Lake Agassiz also alter geochemical response. Lake sediment data can be presented in many ways, including proportional dots, classes, and surface maps. Data from a lake sediment survey carried out around Snow Lake is used to illustrate the components of a lake sediment survey, including planning, collection and analysis, presentation and interpretation.

BIOGRAPHY:

Martin came to the Geological Survey of Canada in 1984 with a B.Sc. from Carleton University, previously mapping greenstones and granites around Lake of the Woods for the Ontario Geological Survey. He has spent his entire career at the GSC with the applied geochemistry group (National Geochemical Reconnaissance) and has extensive field experience, having carried out lake and stream surveys in every province and territory in Canada (except PE). Martin has played a role in several national geoscience programs, recently completing five years with the Northern Resources Development program, leading diamond and base metal exploration projects in the Buffalo Head and Clear Hills of northern Alberta and northeastern British Columbia. Martin is currently involved with two projects focusing on regional geochemistry in northern Canada and the Canadian component of an international soil sampling program.