DEVONO–MISSISSIPPIAN SYNGENETIC BASE-METAL DEPOSITS: NEW DISCOVERIES, NEW DIRECTIONS

Moderators: Steve Gordey (Geological Survey of Canada) and JoAnne Nelson (BC Geological Survey)

08:30 Opening Remarks and Introduction: *Remarks by Ministers and Dignitaries.*

09:05 Cardiac Creek Zn–Pb–Ag Deposit, Akie Property
Paul Baxter, John Kapusta, Ian Morrison, Gary Wells, Inmet Mining Corporation*

The Akie property, located 270 km northwest of Mackenzie, British Columbia, and 25 km southeast of the Cirque Zn–Pb–Ag–Ba deposit, is currently being explored by Inmet Mining Corporation. Inmet, as operator, holds a 60% interest in the property and joint venture partner Ecstall Mining Corporation holds 40% interest.

The property is situated within the Gataga district of the Kechika trough at the southern extent of the Selwyn basin. Several significant SEDEX–type Zn–Pb–Ag deposits are hosted within the basin, notably Howard's Pass, the Faro (Anvil) camp, MacMillan Pass camp, Driftpile and Cirque deposits. Within the Gataga district, sulphide mineralization is developed within the Gunsteel formation, an Upper Devonian–aged sequence of graphitic shales overlying Silurian–aged calcareous siltstones. Mineralization is typically intercalated within the graphitic shales as fine grained, massive to well bedded pyrite, sphalerite and galena with appreciable barite and carbonate. Remobilized sulphide mineralization occurs as veinlets in the surrounding lithologies.

Inmet optioned the Akie claims in 1992 and has since carried out exploration for SEDEX–type Zn–Pb–Ag mineralization in the form of geological mapping, prospecting, soil and lithogeochemistry, resistivity surveys and drilling. In 1994, Inmet geologists discovered outcropping high grade massive sulphide mineralization in "Cardiac Creek" (16% Zn, 2.8% Pb over 40 cm) and subsequently defined by drilling a significant sheet–like deposit of massive and semi–massive sulphides over a strike length of 1600 metres and dip length of 800 metres. True thicknesses of mineralization range up to 30 metres. The deposit remains open at depth.

The Cardiac deposit conforms to a SEDEX model. Sulphide mineralization is well bedded and stratiform in nature. The host lithologies of carbonaceous and pyritic shale suggests a sediment–starved, reducing environment of deposition. The distribution of coarse footwall breccia units as well as metal and geochemical zonations within the deposit are potentially useful vectoring tools for identifying syngenetic growth structures and the focus to the hydrothermal venting. Future exploration will be directed towards following these vectoring criteria, as well as testing other SEDEX targets on the property.

09:25 The Northern Kechika Trough: New Geologic Insights and Indications of SEDEX Potential
Filippo Ferri, Chris Rees, and JoAnne Nelson, BC Geological Survey.*

The Early to Middle Paleozoic Kechika Trough is a southwest-trending extension of the Selwyn Basin. In Paleozoic times it was bounded to the east by the shelf and platform of ancestral North America and to the west by the Cassiar Platform. These basins contain some of the Canadian Cordillera's most important sedimentary exhalative Pb-Zn-Ba deposits, including the Cambrian(?) Anvil camp, the Silurian Howard's Pass deposits and the important Late Devonian Earn-hosted deposits such as the Cirque, Driftpile, Tom and Jason.

The broad stratigraphic signature of the Kechika Trough is similar to the coeval Selwyn Basin. Recent detailed mapping within central and southern Kechika Trough indicates stratigraphic facies variations reflecting a northwestward deepening along the trough axis. This is particularly well developed in rocks of Cambro-Ordovician and Early to Middle Devonian ages. Shallow water clastics and overlying carbonates of Cambrian age disappear northwestward within the trough and are replaced by finer grained siliciclastics reflecting a lower energy, deeper water environment. Early Cambrian alkalic mafic to felsic volcanism occurs in the vicinity of the transition point in the Gataga Mountain area. Overlying carbonates and slates of the Cambro-Ordovician Kechika Group also display facies variations which mimic those in underlying Cambrian rocks. Thick sequences of calcareous slate, slate and limestone overlie thick Cambrian limestone and coarse siliciclastics whereas only thin sections of dark slate sit above more basinal Cambrian siliciclastics. Dolomitic siltstone ('Silurian Siltstone') of the Road River Group forms an essentially uniform unit within the trough, but is locally removed along unconformities. Northwest-trending Early and Middle Devonian carbonate reefs of the upper Road River Group are developed in southern Kechika Trough and disappear northward into slates and calcareous slates.

Fine-grained siliciclastics of the Upper Devonian to Mississippian Earn Group extend far beyond the Kechika Trough and represent a profound change in deposition on the North American miogeocline. This unit essentially marks the end of carbonate deposition along much of the northwestern platform and shelf with carbonate deposition having receded far to the southeast. Concurrent with this is the deposition of coarse clastics within the western extents of the Earn Group which for the first time during the Paleozoic of the Canadian Cordillera indicate a westerly source. These coarse clastics form westwardly thickening wedges in the southern Kechika Trough. This widespread marine transgression has been attributed to rifting along the westernmost part of the miogeocline or to contractional deformation.

The generally low sedimentation rates within the Kechika Trough, together with favourable tectonic elements, allowed sedimentary exhalative deposits to form at

various times. They occur in the Ordovician, the Silurian and most importantly in the Upper Devonian. Mapping in the Gataga Mountain area of central Kechika Trough located mineralization in Cambro-Ordovician and Upper Devonian rocks. A few thin baritic horizons are found at the base of the Kechika Group and in slates of the lower Road River Group. The majority, however, are hosted by the Upper Devonian Earn Group. Several dozen barite occurrences have been documented, apparently near the base of the Earn Group, and range from thin lenses of baritic siltstone or limestone to massive baritic horizons up to several metres thick. At one locality, a barite 'kill zone' covering in excess of 3500 square metres is developed. The thickness and distribution of these baritic layers within parts of the Gataga Mountain area suggest a widespread semi-continuous baritic horizon prior to structural disturbance. Sulphide mineralization is generally not associated with the barite, but sulphides are present in cross-cutting Zn-Ba breccia at the very top of the Road River Group; and in a Pb-Ba stringer zone in the Earn Group. These occurrences may be associated with the widespread barite mineralization.

09:45 Age Constraints on Ba–Zn–Pb Sedex Deposits, Gataga District, Northeastern British Columbia

Suzanne Paradis, JoAnne Nelson and Steve Irwin, Geological Survey of Canada and BC Geological Survey[2]

The Gataga district of the Kechika Trough is one of the most promising areas for SEDEX–type mineralization in North America. The most economically significant SEDEX deposits in the Gataga district are part of a Devonian–Lower Carboniferous marine sequence of basinal shales and turbidites which occur in NW–trending second– and third–order depositional basins within the Kechika Trough, a SE extension of the Selwyn Basin. These include the Cirque, Driftpile, Bear, Elf, Fluke, and Akie deposits.

These deposits are hosted by fine–grained carbonaceous and siliceous clastic rocks of the Middle to Late Devonian Lower Earn Group, Gunsteel Formation. This study indicates that several distinct mineralizing events occurred within the Earn Group during late Devonian time.

Conodonts are microfossils that are used for stratigraphic chronology and correlation. A biochronological framework for the Driftpile, Bear, Fluke, Elf, and Cirque deposits was developed with the examination of Late Devonian conodonts from the deposits. Late Devonian, Famennian conodonts have been identified with the host rocks (Earn Group) of the SEDEX deposits from the Gataga district. Well preserved faunas consist of deep water genera dominated by platform elements of *Palmatolepis*. The majority of the species range in age from Upper *crepida* through *expansa* zones, and constrain the mineral units as Upper *postera* – Lower *praesulcata* for the Cirque deposit, Lower *marginifera* – Upper *trachytera* for the Fluke deposit, *trachytera* for the sulphide–carbonate facies of the Driftpile deposit, and Upper *marginifera* for the barite–sulphide facies of the Driftpile deposit. Conodont ages have mandated the present of at least one cryptic thrust fault in the main zone at Driftpile.

10:05 Red Dog's Aqqaluk (Red Dog Extension) Deposit: World Class Zinc Discovery in Northwest Alaska

James Kulas, Cominco Alaska Incorporated

During the summer of 1995, Cominco discovered a huge ore zone at Red Dog. The new discovery, the Aqqaluk Deposit, is estimated to contain 83,831,000 tons (76M tonnes) averaging 13.7% Zn, 3.6% Pb and 1.9 oz/t (66g) Ag.

Red Dog is a mine and mill complex operated by Cominco Alaska Incorporated in partnership with the NANA Regional Corporation. It is located 600 miles (965 km) northwest of Anchorage, Alaska. On July 18 a hole located one–quarter mile north of the mine intersected a 540 foot (165m) section containing 16.1% Zn and 3.2% Pb. By October 5, a 48 hole drill–grid had been completed over the new ore zone.

The orebody is a Mississippian to Permian aged sulfide deposit located in the western Brooks Range. It is a black shale hosted sedimentary exhalite deposit but is atypical due to rare sulfide sedimentary textures. Pervasive silicification, and much of the mineralization, is replacement in nature. A Jurassic to Cretaceous age compressional event has repeated the ore section.

Red Dog occurs in three stacked thrust plates; the lower most plate contains the entire Aqqaluk Deposit. This plate's thrust sole is synformal and the geometry of the ore zone is lenticular. The ore zone's western edge is a facies change into unmineralized host. It appears to be structurally thinned in all other directions. Sphalerite and galena occur in silica rock, barite rock and the host shale (Ikalukrok Member, Kuna Formation). Sulfides are disseminated, semi–massive to massive and rarely laminated. Late cross–cutting sulfide veins cut the host shale and the exhalite package. Angular breccias are common and vent fauna occurs locally.

10:25 Devono-Mississippian Tectonics and Mineral Deposits of the Cordilleran Margin

Steven Gordey, Geological Survey of Canada

In pre–Late Devonian time the northern Cordilleran miogeocline comprised an extensive shallow water carbonate–clastic platform flanked westward by deep water shale, chert and carbonate. Clastic sediments had been derived from the craton to the east. In the late Devonian this scenario abruptly changed with the influx of thick sequences of turbiditic chert–rich clastic rocks of westerly and northerly derivation. Coarse clastics (in sections up to 2500 m) overlapped the western offshelf facies whereas shale covered the early Paleozoic carbonate platform on the east. The coarse clastics were deposited on submarine fan or fan-channel complexes in which pebble to cobble conglomerate, sandstone, and minor pebbly mudstone formed local massive channel deposits up to 200 m thick. Except in northern Yukon and Alaska, fluvial equivalents of these deep marine sediments are unknown. By mid–Mississippian time the basin had been filled or had shallowed, the clastics were succeeded by shallow marine quartz arenite or carbonate, and clastic input from the craton was re–established.

Over large areas the clastics are of uniform composition. Chert and quartz occur in subequal amounts with traces of plagioclase and orthoclase. Rounded to angular chert

clasts characterize the conglomerates but gritty quartz sandstone clasts are common as coarse pebbles or cobbles. Locally, silicified clasts of sandy dolomite are abundant. The composition indicates intrabasinal derivation from uplifted blocks in the outer miogeocline exposing early Paleozoic shale, chert, and carbonate, and late Proterozoic-Cambrian sandstone.

Sedimentary exhalative barite and lead–zinc–silver–barite deposits are a hallmark of the Devono–Mississippian clastic succession. Barite is common, and ranges from horizons of scattered small nodules to occurrences of massive and laminated barite up to 100 m thick (Tea deposit, Yukon). Economically important, sulphide deposits include the Tom and Jason properties in Yukon, and the Akie, Cirque and other deposits of the Gataga district of northeastern British Columbia. Copper–lead–zinc volcanogenic massive sulphide prospects such as the Marg and MM properties in Yukon are related to local, generally thin felsic volcanic rocks, which also typify the succession. Available age and fossil (conodont) control indicate multiple ages of mineralization within the Late Devonian and Early Mississippian. The large submarine exhalative, zinc–lead–silver Red–Dog deposit in northwestern Alaska, is slightly younger and in a different setting than the Canadian examples, occurring in offshelf siliceous shales and cherts of Early Mississippian to Early Pennsylvanian age.

Two geographically separate and fundamentally different tectonic regimes seem responsible for the mid–Paleozoic clastics. In northern Yukon tectonism involved uplift and granitic intrusion in Frasnian to early Mississippian time, resulting in an upward shoaling and southward prograding clastic wedge. Compressional deformation (Ellesmerian orogeny) migrated southward resulting in eventual folding of the clastics prior to the mid-Carboniferous.

In central Yukon and British Columbia, a lack of compressional deformation, the presence of local volcanics of rift type, sedimentary exhalative base metal deposits, clastic provenance, and syn-sedimentary faults that may have partly controlled thickness and facies indicate block uplift of the outer miogeocline as a consequence of regional extension or strike-slip faulting. There is no indication that western, peri–cratonic terranes (e.g., Yukon–Tanana) exerted any influence on the Devono–Mississippian evolution of the outer miogeocline.