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Exploration History and Mineral Potential of the Central Arctic Zn-Pb District, Nunavut

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ABSTRACT. Exploration in the central Arctic Zn-Pb District took place in five phases: 1) an initial exploration period (1960–70), during which most surface showings on Cornwallis and Little Cornwallis islands were found; 2) a discovery period (1971–79), during which the buried Polaris ore body was discovered and its feasibility and viability established, new showings were found farther afield, and many showings received limited drill testing; 3) the production period (1980–88), dominated by drilling at Polaris Mine; 4) an ore-replacement exploration period (1989–2001), during which showings close to Polaris were extensively drilled, showings on Cornwallis Island drill tested, and new showings found and drilled farther away; and 5) a reclamation period (2002–05), during which the infrastructure was removed and the mine site restored. Factors affecting the timing and rate of exploration were generally intrinsic to the region: 1) discovery of showings in 1960, 2) discovery of the Polaris ore body in 1971, 3) declining reserves between 1989 and 2002, 4) closure of the mine in 2002, 5) the short exploration season and difficult logistics, and 6) lack of competition. The external drivers of exploration were 1) oil-related exploration that led to the discovery of the Polaris showings, 2) the onset of regional exploration coinciding with spikes in the price of zinc, and 3) the surge in scientific interest in carbonate-hosted Zn-Pb deposits in 1967. Probabilistic, discovery-time curve analysis indicates that over 50 showings remain undiscovered. Because logistics controlled the target selection, the standard assumption of a logical discovery process (from largest target to smallest target) is likely invalid. This means that large, untested targets may still exist in the district.

Key words: Polaris Mine, Cornwallis Island, Little Cornwallis Island, Arctic Islands, zinc, lead, mining, Mississippi-Valley type, mineral potential, discovery curve

RÉSUMÉ. Les travaux d’exploration dans le district de Zn-Pb du centre de l’Arctique se sont déroulés en cinq étapes : 1) une période d’exploration initiale (1960-1970), durant laquelle la plupart des traces détectées sur l’île Cornwallis et la Petite île Cornwallis ont été trouvées; 2) une période de découverte (1971-1979), pendant laquelle la zone de minéralisation enterrée de Polaris a été découverte et sa faisabilité et sa rentabilité ont été déterminées, de nouvelles traces ont été décelées plus au loin, et de nombreuses traces ont fait l’objet d’un nombre restreint d’essais de foration; 3) une période de production (1980-1988), dominée par les travaux de foration à la mine Polaris; 4) une période d’exploration de remplacement de minerai (1989-2001), dans le cadre de laquelle les traces situées à proximité de Polaris ont fait l’objet de forations intenses, les traces de l’île Cornwallis ont fait l’objet d’essais et de nouvelles traces ont été découvertes et forées plus loin; et 5) une période de remise en état (2002-2005), durant laquelle l’infrastructure a été retirée et l’emplacement de la mine a été restauré. Généralement, les facteurs touchant la programmation et le régime d’exploration étaient intrinsèques à la région : 1) la découverte des traces en 1960, 2) la découverte du corps minéralisé de Polaris en 1971, 3) la diminution des réserves entre 1989 et 2002, 4) la fermeture de la mine en 2002, 5) la courte saison d’exploration et la logistique qui présentait des difficultés, et 6) l’absence de concurrence. Les motifs externes à l’exploration étaient les suivants : 1) l’exploration pétrolière qui a engendré la découverte des traces de Polaris, 2) le début de l’exploration régionale qui coïncidait avec les variations brusques du prix du zinc, et 3) l’intérêt soudain, dans le monde scientifique, envers les gisements de Zn-Pb dans la roche hôte carbonatée en 1967. L’analyse probabiliste de la courbe de découverte par rapport au temps indique que plus d’une cinquantaine de traces n’ont toujours pas été découvertes. Puisque la logistique décidait du choix des cibles, il est très vraisemblable que l’hypothèse standard d’un processus de découverte logique (de la cible la plus grande à la cible la plus petite) ne soit pas valable. Cela signifie que de vastes cibles n’ayant pas fait l’objet d’essais existent encore dans le district.

Mots clés : mine Polaris, île Cornwallis, Petite île Cornwallis, archipel Arctique, zinc, plomb, exploitation minière, type de la vallée du Mississippi, potentiel minier, courbe de découverte

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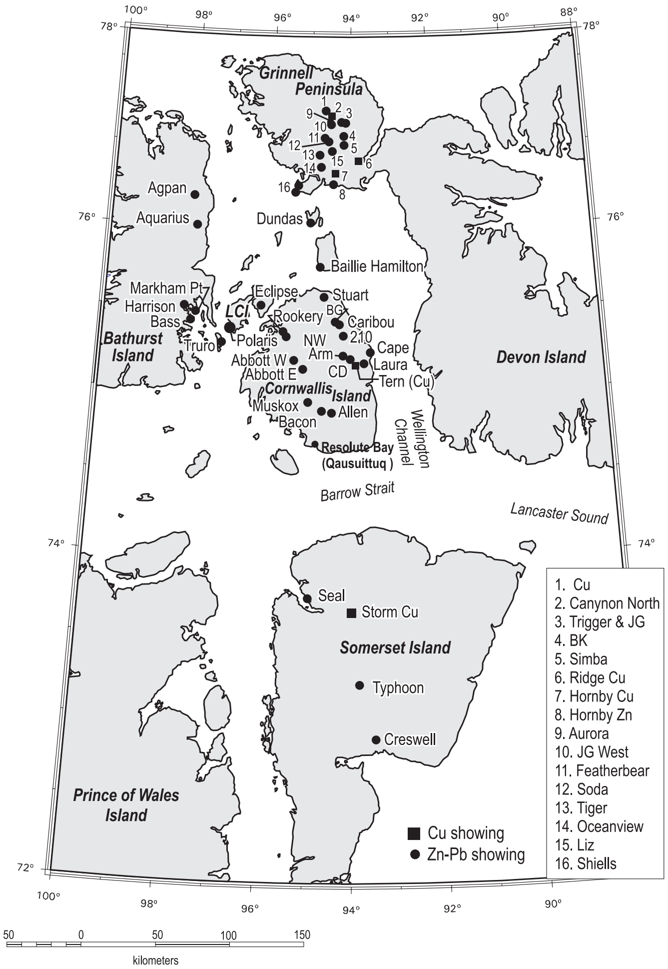

FIG. 1. Location of the central Arctic island Zn-Pb District, showing distribution of mineral showings. Some dots represent clusters of closely spaced showings.

INTRODUCTION

The Zn-Pb District in the central Arctic islands of Nunavut provides an unusual opportunity to examine a complete mineral exploration cycle in a northern frontier area and to document some of the internal and external drivers that affected the exploration, discovery, and extraction process. This paper documents the exploration history of the district and the results achieved by the initial exploration programs. This 45-year exploration cycle may contain clues that will inform predictions of remaining mineral potential, especially predictions based on probabilistic discovery-curve models. Lastly, insight into the decision-making process in the central Arctic Zn-Pb District may be useful to future government or corporate entities trying to initiate resource exploration in remote areas.

The central Arctic Zn-Pb District spans an area that is roughly 450 km north-south by 130 km east-west. About 80 individual Zn-Pb showings occur within the study area, from Somerset Island in the south to the Grinnell Peninsula of Devon Island in the north (Fig. 1). The largest deposit in the district was the Polaris Mine, located at 75˚23' N 96˚57' W on the southwest side of Little Cornwallis Island. The Polaris Mine, in continuous operation from its start-up in 1980 to September 2002, was owned in part by Cominco Ltd (77.5%). The remaining 22.5% was owned by various other mining companies (Bankeno Mines, Teck Corp., Rio Algom, etc). Mineralization was originally noted by an oil exploration crew in 1960. A summary of the exploration history is given in the Appendix.

The Polaris deposit was a carbonate-hosted, Mississippi Valley–type Zn-Pb deposit of about 20 million tonnes grading about 17% Zn + Pb. The mined ore body was 300 m wide by 800 m long by 20 to 150 m thick and consisted of sphalerite and galena, along with the gangue minerals pyrite, dolomite, and calcite (Savard et al., 2000). The Polaris deposit was hosted in Middle Ordovician (460 million years old) limestone of the Thumb Mountain Formation. The ores probably formed at 368 Ma during the latest Devonian or Early Carboniferous mountain-building event in the Arctic Islands (Christensen et al., 1995). The geology of the Polaris deposit, shown in Figure 2, has been described by Kerr (1977), Randell (1994), Sharp et al. (1995a, b), Randell and Anderson (1997), Randell et al. (1997), Savard et al. (2000), and Dewing et al. (in press). Studies of individual showings other than Polaris are published in Thorsteinsson (1984), Harrison and de Freitas (1996), Rose (1999), Turner and Dewing (2002), and Mitchell et al. (2004).

Access into the mine site was provided year round by Twin Otter aircraft flying from Resolute Bay (Qausuittuq), located 100 km southeast of the Polaris Mine. Resolute Bay was serviced during the life of the mine by jet aircraft flying twice weekly from Montreal and Edmonton and once weekly from Ottawa and Yellowknife. Aircraft transported people, perishable food, and supplies. Fuel and non-perishable items came by sealift. A workforce of 235 employees worked on rotation (8 weeks on site and 4 weeks off site) with return flights provided to their residences anywhere in Canada.

An accommodation building contained 240 rooms, as well as a swimming pool, commissary, and other recreational facilities. Heat was supplied from waste heat recovered from the three generators in the powerhouse.

The building known as "the barge" housed the concentrator, offices, warehouse, heavy equipment, and other repair shops, as well as the powerhouse. The concentrator complex was built on a barge in Trois Rivières, Quebec, and towed to the site, where it was anchored in an excavated lagoon and surrounded by rock fill. The very large concentrate storage shed, built on site adjacent to the barge, could store 170 000 tonnes of zinc and 40 000 tonnes of lead concentrate, or approximately nine months' worth of production. Oceangoing ships docked near the barge and were loaded directly with a conveyor system. Transit time to smelters in Europe was approximately 10 days from Polaris. Ocean-going freighters arrived in early July and shipments continued until late October.

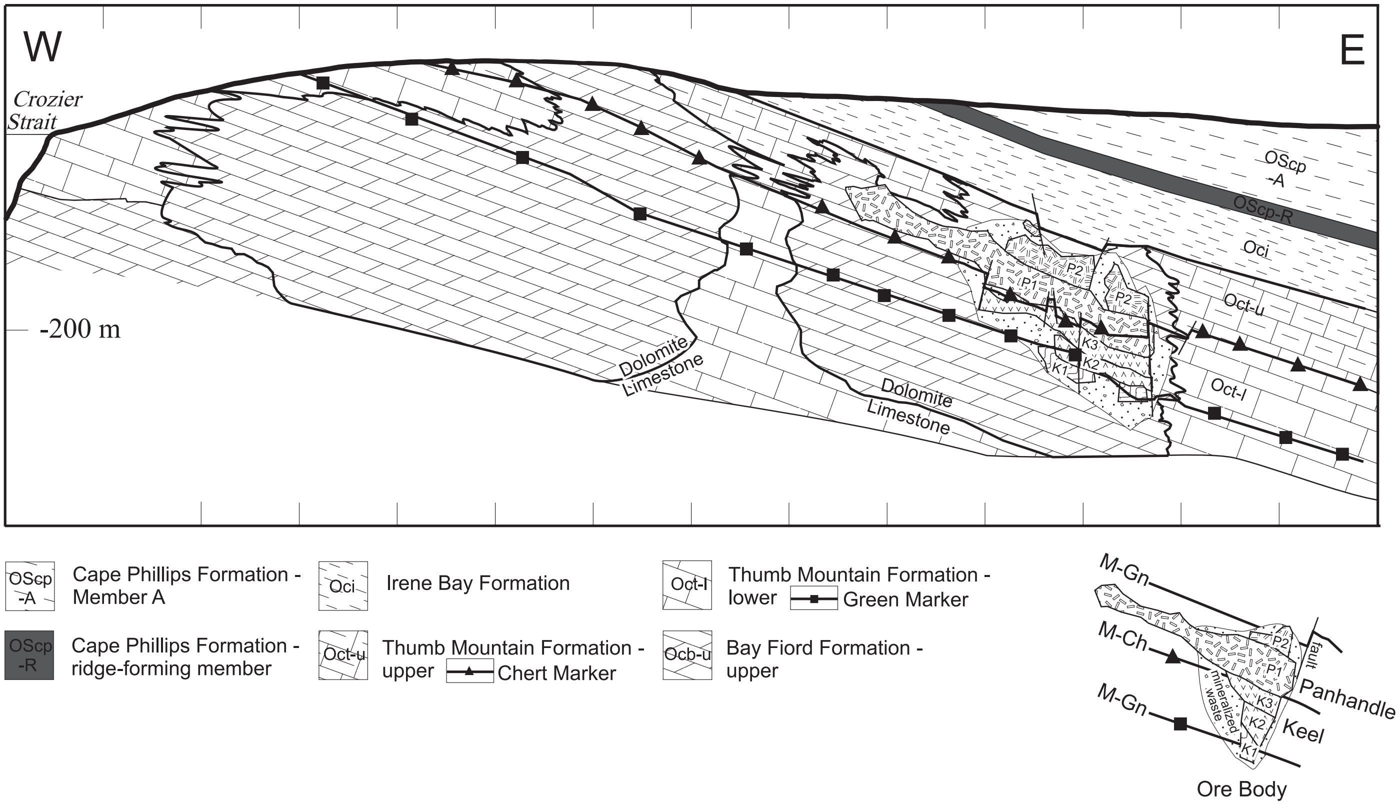

FIG. 2. Section looking north through the Polaris Mine, showing the outline of the ore and dolomitization (after Randell, 1994). Tick marks on horizontal axes are 100 m apart. The Panhandle Zone forms the upper part of the deposit and is roughly concordant with bedding. Carbonate is almost completely replaced by sulphide. The Keel Zone, which occupies the lower part of the ore body, is composed of a vein stockwork. P1 ore consisted of massive, carbonate replacement, breccia-fill and vein sulphide. P2 ore was composed of thin, vertically oriented veins of sphalerite, marcasite, and galena. Directly underlying the P1 ore is high grade K3 ore, composed of complex, cross-cutting veins along with massive to disseminated sulphides. K3 had lower iron content compared to the P1 ore. K2 ore was composed of fracture-filling and vein sulphides, with lesser replacement of carbonate. The lowermost ore unit is K1 ore, composed of fracture-filling and vein sulphides.

MINING METHOD

Access to the mine was via two portals: the main one adjacent to the barge and a second located at the north end of the Polaris Peninsula. Ore was mined underground by sublevel long-hole stoping. Primary stopes 15 m wide and 100 to 150 m long were separated by 18 m wide rib pillars, which were mined later (Fig. 3). Mining was sequenced starting from the bottom and working up in the stopes and from the east end working west in the pillars. Both the topcut and undercut were 8 m wide by 5.5 m high drifts that ran east-west along the centre line of the stope. At the end of each stope, a 1.8 m diameter raisebore hole served as ventilation and as the entry site for backfill once the stope was mined out. Primary stoping in the Panhandle Zone (Figs. 2 and 3) was complete in 1985, and primary stoping in the Keel Zone in 1997. Pillar mining began in the Keel in 1987.

Broken ore was extracted by 12-yard scoop trams, operating on remote control, which loaded 26 tonne trucks for haulage to the ore pass. All mining was trackless, using diesel-powered equipment with electric hydraulic drills drawing power from the barge by an underground distribution system. The broken muck was drawn down through the orepass to the bottom of the mine, where it was crushed, and then conveyed to underground coarse ore bins near the surface.

A conveyor from the coarse ore bins fed a cone crusher in the mill. Two ball mills ground the feed and distributed the undersize to flotation and column cells. The lead and zinc concentrate was dewatered with a filter press and dried in a rotary dryer, using waste heat from the powerhouse diesel engines. The concentrate was stored in the storage shed.

Backfill, composed of broken shale with 10% to 13% moisture, was dumped into the open stopes via the raisebore holes. The backfill was then left to freeze for about two years. The adjacent pillar could be removed and the exposed frozen backfill column (80 m high by 14 m wide) would remain stable (Keen, 1992). Backfill was obtained from two quarries to the east of the mine site. Starting in 1996, a cemented rock fill was used to increase the strength of the backfill. This consisted of limestone obtained from a quarry at the north end of Polaris Peninsula and coated with a thin layer of cement. Cemented rock fill was needed to counteract the increased lithostatic load caused by settling of the overlying strata.

Permafrost extends up to 500 m below the surface at the Polaris Mine. Rock temperatures vary from –14˚C near the surface to –3˚C at the bottom of the mine. The freezing

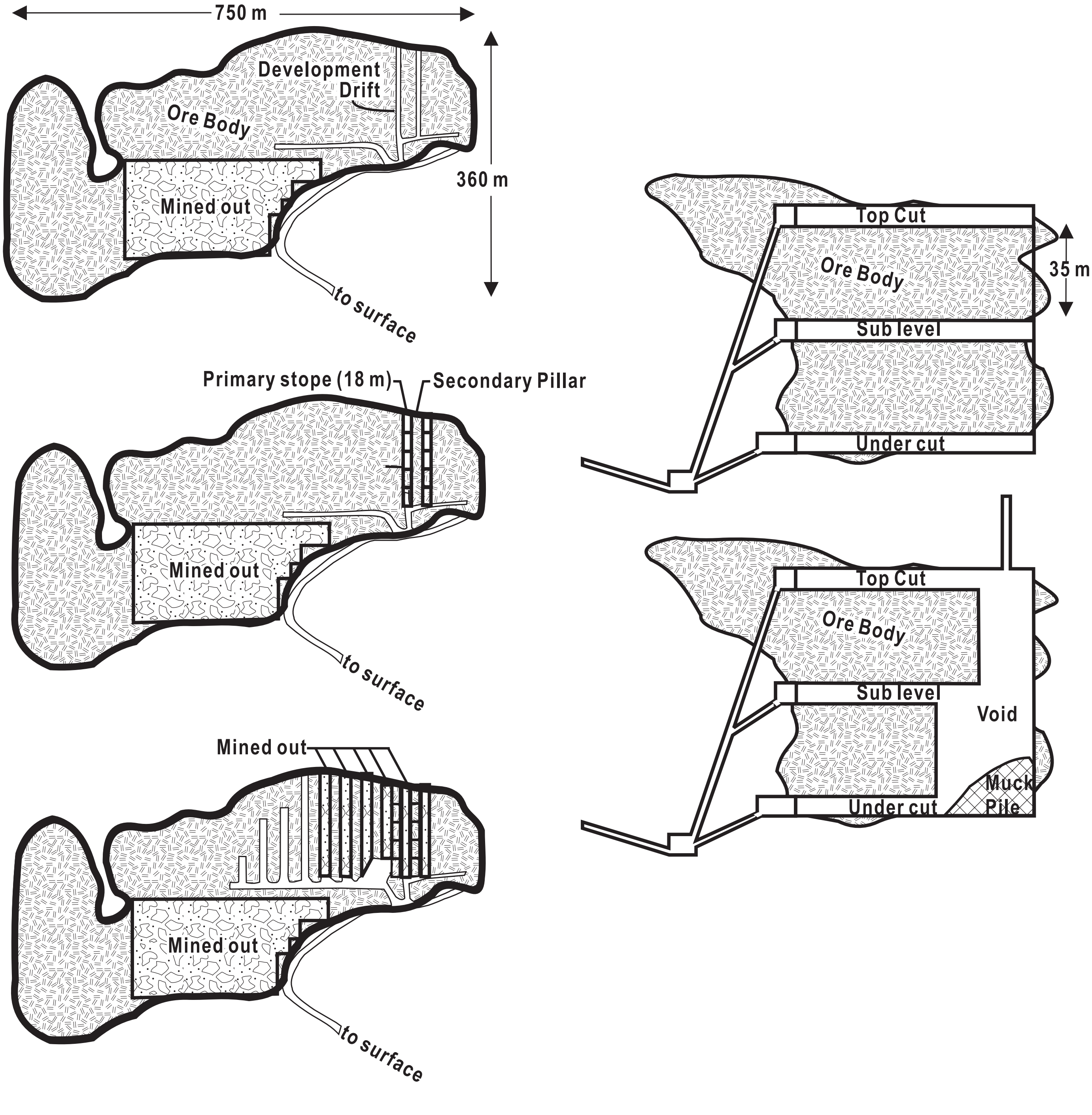

FIG. 3. Mining method at Polaris Mine. The left side shows the mining sequence in plan view. Development drifts (top) were used as drill platforms to develop the primary stopes (middle). The primary stopes were extracted in stages, each about 15 m long. Once the primary stopes were removed, filled with backfill and frozen, then the secondary pillars could be removed in stages (bottom). The right side shows a sectional view. The top right figure shows the development drifts. The bottom right figure shows the stages being removed.

conditions existing throughout the workings meant that the mine was dry and the rocks remained very competent when frozen. For the two summer months, the mine intake air was refrigerated to counterbalance the input of heat from mining equipment, freshwater in the backfill, and electrical power.

Tailings from the concentrator were piped 2.5 km to a thickener 37 m in diameter near the disposal area. Reclaimed water was circulated back to the mill. Dewatered tailings were placed in the bottom of Garrow Lake, a small saline lake with anoxic bottom water and no vertical circulation. The lake had three distinct layers: an 11 m thick brackish upper layer with some aquatic animals, including sculpin and clams; a transition zone from 11 to 20 m depth, with decreasing oxygen and increasing salinity; and an anoxic bottom zone from 20 to 44 m depth, with salinity three times that of seawater and abundant soluble hydrogen sulphide. Until 1990, Garrow Lake discharged

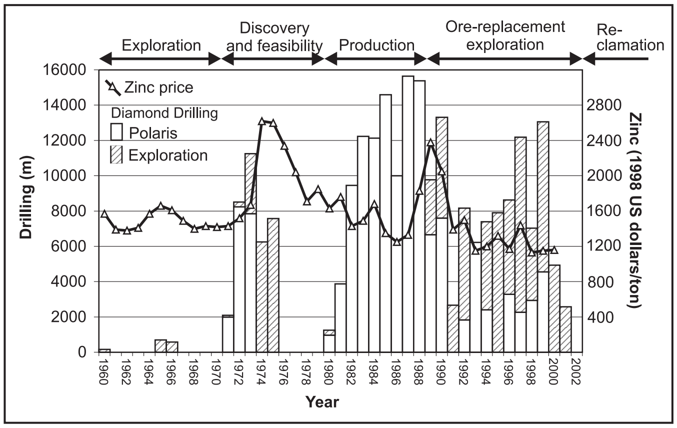

FIG. 4. Exploration and ore-definition drilling in the central Arctic Island Zn-Pb District between 1960 and 2002. High zinc prices in 1974 and 1990 coincide with new rounds of regional exploration. Historical zinc prices are from Plachy (1998).

to the ocean via a small creek in the summer months. In 1990–91, a frozen-core dam was constructed to raise the water level and maintain the upper lake layer. The dam was removed during site reclamation and the water level returned to its original level.

EXPLORATION CYCLE (1960 – 2002)

There were five phases of exploration in the central Arctic Zn-Pb District, as shown in Figure 4 and detailed in the Appendix. The initial exploration phase (1960 – 70) spanned the time between the discovery of the Polaris showings and the discovery of the Polaris ore body. The discovery of the Eclipse, Rookery, Taylor, Stuart, Allen Branch, and Abbott River showings on Cornwallis and Little Cornwallis islands was based mainly on aerial reconnaissance and surface colour anomalies. Prospecting and stream sediment sampling programs were then completed on Cornwallis and Little Cornwallis islands. Work was done primarily by Cominco Ltd, with Canadian Superior Exploration starting an exploration program in 1970. This exploration phase failed to find a large deposit on the surface. Following a review of the existing data, Cominco decided to explore for buried deposits near the known showings, using geophysical techniques.

The second phase (1971 – 79) spans the time between the discovery of the Polaris ore body and the beginning of underground development. The Polaris deposit was drilled in 1971 on an anomaly detected during a gravity survey of the Polaris Peninsula. Delineation drilling was started at Polaris, along with a 1.5 km long exploration adit. Discovery of the Polaris ore body led to a flurry of regional exploration, resulting in the discovery of showings on Truro and Dundas islands and on the Grinnell Peninsula. Most of the surface showings in the district received limited drill testing to see if any were the surface expression of a larger ore body. About half of the exploration drilling was done by Cominco Ltd, and the other half by Canadian Superior Exploration. Drilling ceased between 1976 and 1979, as regulatory approval for the Polaris Mine was sought and mine feasibility studies were completed.

The third phase (1980 – 88) was dominated by ore delineation drilling at the Polaris Mine and exploration on the Polaris Peninsula. Cominco was the only company active in the district.

The fourth phase (1989 – 2002) saw a decline in drilling at Polaris as the deposit was fully delineated and exploration potential in the immediate vicinity of the Polaris Mine was exhausted. Cominco stepped up regional exploration, with extensive drill testing of showings near Polaris (Eclipse and Truro). Distant showings (Rookery, Abbott River, Caribou, and Dundas) were extensively drill tested. New showings were found and drilled on Bathurst and Somerset islands. BHP Minerals (1994 – 96) and Noranda (1997 – 2001) engaged in regional exploration, which culminated in extensive drilling by Noranda on the Grinnell Peninsula. Depletion of the ore body led to closure of the Polaris Mine in September 2002.

The fifth phase (2003 – 05) was the removal of infrastructure from the Polaris Mine site. Buildings were either removed or buried in the old mine workings and in the quarry at the north end of the Polaris Peninsula. Buildings and equipment at exploration sites were also removed. The closure of the mine marked the end of regional exploration by both Cominco and Noranda. The companies' withdrawal was due in part to protracted low prices for zinc and the lack of a large discovery, but the mine closure also resulted in a reduction of logistical support and an increase in costs in the central Arctic Islands. This was especially true for flights from the south (Fig. 5), and exploration crews also lost access to the Polaris Mine's supplies of cheap, sea-lifted salt (for drilling), repair shop, and drills, and could no longer rely on mine staff and equipment to move drills on the ice during the spring.

EXPLORATION RESPONSE

The number of discoveries grew slowly following discovery of the Polaris showing in 1960. The discovery curve (Fig. 6) is step-like, with a number of discoveries made in a short interval (1 to 3 years) followed by a longer period (5 to 12 years) during which no new showings were discovered. This step-like response is likely characteristic of remote areas with a short summer season. An exploration program lasting one to two years makes many discoveries, but then it takes a number of summers to evaluate the new discoveries. Once these showings are proven to be uneconomic, there is a lull during which no exploration takes place.

The discovery rate in the central Arctic Zn-Pb District contrasts sharply with that in the eastern Yukon–western NWT zinc district (Fig. 6). The Yukon-NWT experienced a staking rush in the early 1970s, which led to an extremely rapid discovery rate. A staking rush prompts multiple

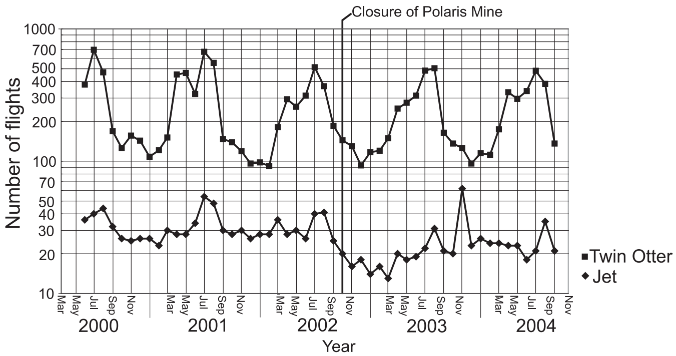

FIG. 5. Landing statistics for the Resolute Bay airport from June 2000 to September 2004. July Twin Otter landings dropped by about 200 following the end of regional exploration in 2001, jet landings dropped by about 10 per month following mine closure in September 2002. (Data from Transport Canada http://www.tc.gc.ca/pol/en/Report/tp141e/tp141.htm.)

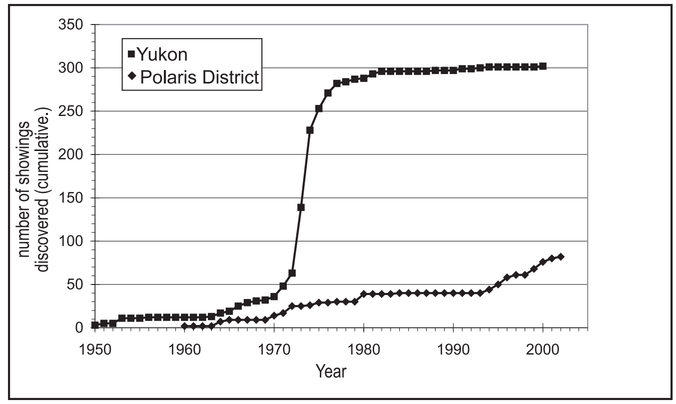

FIG. 6. Cumulative number of known showings in the central Arctic Islands (triangles) and the Yukon-western NWT zinc districts (squares) versus year. The Yukon-NWT experienced a staking rush in the early 1970s, which led to rapid exploration and discovery of showings (data from NWT Normin and Yukon Minfile databases). By contrast, the number of known showings in the central Arctic Islands grew slowly because of the short summer season, absence of competition, and lack of local prospectors.

companies as well as local prospectors to explore intensively to maintain a competitive advantage, or to secure a land position that can be sold. The much slower discovery rate in the central Arctic Zn-Pb District was due to the predominance of a single company (no rush), a short exploration season, high costs, and the lack of local prospectors.

The total number of showings in the district can be estimated by plotting the cumulative discovery curve against a logarithmic scale (Fig. 7). This kind of discovery curve model is frequently used in the oil and gas industry to predict the total resource endowment of a petroleum field or province (e.g., Chen et al., 2000). In the central Arctic Zn-Pb District, the total number of showings is estimated to be about 135, of which 82 are known.

The cumulative discovery curve also helps illustrate the stepwise discovery process. The upward step shows a number of discoveries being made in a one- to three-year exploration program. This step is followed by a period during which the newly discovered showings are assessed by mapping, geophysics, and drilling. There is then a lull (labelled "disappointment" on Fig. 7). Once the number of discoveries drops below the expected discovery curve (the smooth curve on Fig. 7), there is a sense that the district is under-explored and a new exploration program begins. As more showings are discovered, there is a long period between exploration programs because the expected rate of discovery drops and it takes longer to generate a sense that an area is under-explored.

Most discovery processes are logical; first the largest target is tested, and then progressively smaller targets are sought out. This pattern holds especially true in the oil and gas sector, where there are independent measures of prospect size (i.e., seismic closure) and fewer financial constraints. Figure 8 shows the distance of oil wells in the Arctic Islands from the main oil and gas staging area at Rae Point on Melville Island. The graph shows that there were few logistical constraints in the early part of the exploration program, and many wells were drilled at a great distance from Rae Point. As the exploration cycle progressed, wells were drilled closer to the main discoveries

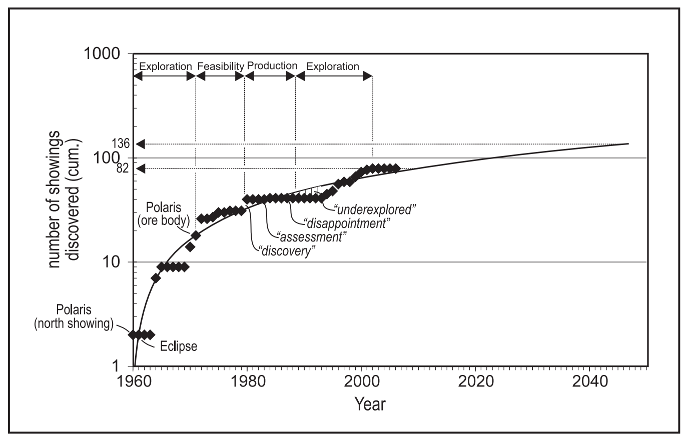

FIG. 7. Discovery curve in the central Arctic Islands District. The cumulative number of known showings is plotted on a logarithmic scale against year of discovery. A best-fit curve is fitted to the resulting "discovery curve." Eighty-two showings are known, and the best-fit curve indicates that as many as 50 showings remain to be found. The discovery curve has a step-like appearance. The parts of the step are "discovery," during which many showings are found during a one- to three-year exploration program; "assessment," during which the newly discovered showings are evaluated; "disappointment," during which exploration is on hold; and finally "under-explored," when the mineral district is again perceived to be prospective. This diagram predicts that a sense of being under-explored will occur only after 2010, and new exploration in the central Arctic Islands will be unlikely to occur before 2015.

on northern Melville Island as Panarctic tried to increase reserves to make an economically viable project.

The central Arctic Zn-Pb District is different. Exploration generally progressed from Polaris outward (Fig. 9), and logistics rather than geological prospectivity controlled the exploration program. This approach likely resulted from the smaller budgets available for mining exploration, the economic advantage of finding additional reserves close to the producing mine, and the lack of reliable criteria for ranking a showing's exploration potential. Because logistics rather than geology controlled the target selection, the standard assumption of a logical discovery process (from largest target to smallest target) is likely

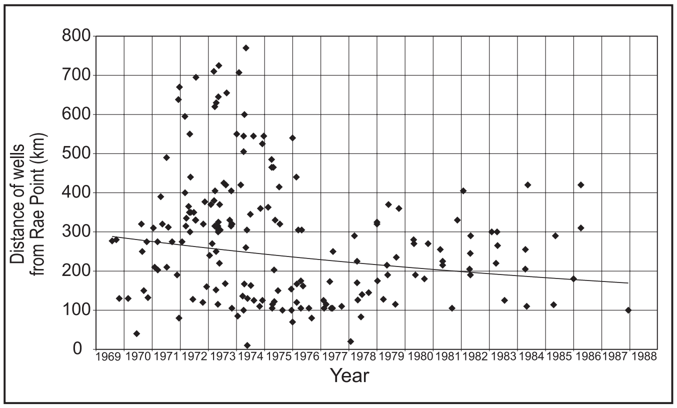

FIG. 8. Distance of Arctic oil and gas wells from the main Panarctic staging point at Rae Point on Melville Island. Distant targets were tested early in the Panarctic exploration program, but later exploration became increasingly restricted to areas near the main discoveries on northern Melville Island. This pattern agrees well with a logical discovery process in which geological targets are tested in order, from largest to smallest.

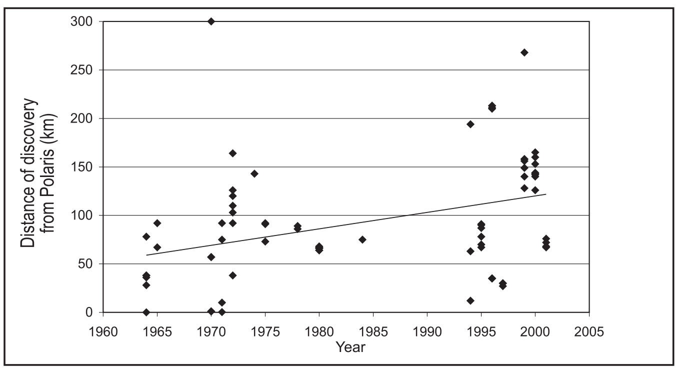

FIG. 9. Distance of discovered showings from the Polaris Mine versus year of discovery. There is a general progression from near to far, indicating that logistics and economics governed the exploration more than the attractiveness of the geological target.

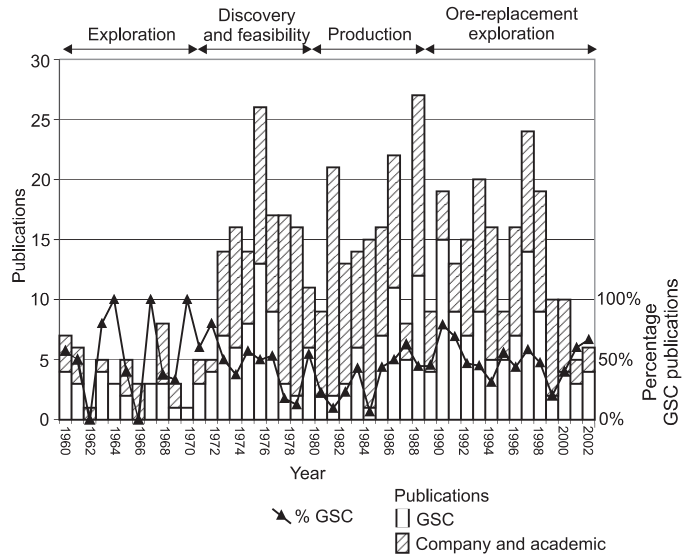

FIG. 10. Publication record for the central Arctic Islands extracted from the bibliographic databases Georef and Geoscan. The Geological Survey of Canada accounted for most of the publications early in the exploration history, but academic and industry papers dominated following the discovery of the Polaris ore body in 1970.

invalid. This means that large, untested targets may still exist in the district.

SCIENCE RESPONSE

Geological publications on the district were extracted from the bibliographic databases Georef and Geoscan (Fig. 10). The Geological Survey of Canada (GSC) provided most of the early (pre-1970) geological information. The proportion of GSC publications decreased as exploration companies and researchers increased their activity in the central Arctic. Academic publications generally increased from 1960 until the early 1980s, whereas the number and proportion of GSC publications decreased during the feasibility and production phases of the exploration cycle. This pattern matches the expected role of a government geoscience agency: to help set the geoscience framework and then reduce its level of activity while others are working in the area.

The number and proportion of GSC publications increased just prior to the start of the ore-replacement exploration phase (Fig. 10). These publications included regional summaries and new mapping on the Grinnell Peninsula, at the north end of the central Arctic Zn-Pb District. Once ore replacement exploration was underway, the GSC reduced its activities in the district.

CONCLUSIONS

Factors affecting the timing and rate of exploration are generally intrinsic to the region: 1) the discovery of showings in 1960, 2) the discovery of the Polaris ore body in 1971, 3) declining reserves between 1989 and 2002, 4) the closure of the mine in 2002 and attendant loss of logistical support, 5) the short exploration season and difficult logistics, and 6) lack of competition.

The external drivers to exploration are 1) oil-related exploration, which led to the discovery of the Polaris showings; 2) the onset of the two regional exploration periods (1974 and 1989) coinciding with zinc price spikes (Fig. 4) (otherwise there is little correspondence between commodity price and exploration activity), and 3) the surge in scientific interest in carbonate-hosted Zn-Pb deposits in 1967 (Fig. 11) helped industry geologists get their exploration program approved.

As many of the factors affecting exploration are intrinsic to the region, policy makers interested in resource evaluation and exploration in frontier areas like the Arctic Islands are somewhat limited in their options. Those seeking to assess, promote, or prevent resource development should pursue (or prevent) a coordinated approach that would include 1) incentives to look for a high-value commodity (in the case of the Arctic Islands, exploration for high-value oil led to discovery of low-value gas and zinc

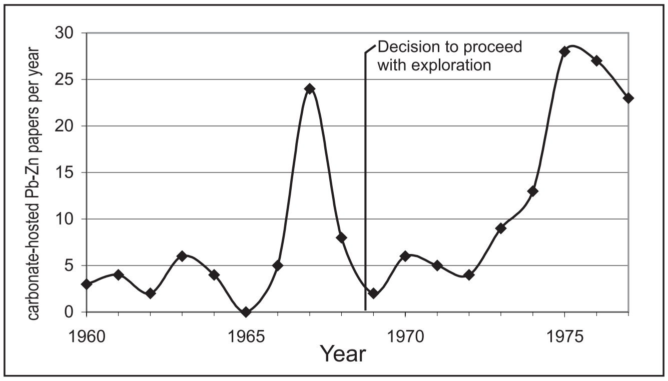

FIG. 11. The number of papers on carbonate-hosted zinc deposits (also known as Mississippi-Valley type) between 1960 and 1977. The large number of papers in 1967 was a factor in raising interest in this deposit type and in the decision by Cominco to proceed with exploration in 1969–70 (see Appendix).

deposits); 2) generation of new exploration concepts; 3) training of local prospectors; 4) a database of costs needed to explore, extract, and market ore in remote areas for realistic economic models, and 5) formulation of better ways to evaluate showings to change from a logistics-dominated to a target-dominated discovery process.

APPENDIX: SUMMARY OF ANNUAL EXPLORATION ACTIVITY

1950–54

Initial mapping of Cornwallis and Little Cornwallis islands was carried out by the Geological Survey of Canada (Thorsteinsson, 1958).

PHASE ONE

1960

Geologist Lionel Singleton with J.C. Sproule and Associates, under contract to Bankeno Limited for oil and gas exploration, landed on Little Cornwallis Island to look at a whale skeleton and discovered the north showing at Polaris. Jack McBean (vice president of Bankeno) instructed Gordon Bragg, a mine geologist at related company Upper Canada Mines, to go to the Arctic. Bragg contracted “Weldy” Phipps of Atlas Aviation in Resolute Bay. They used Weldy’s Supercub on oversized soft wheels to fly to Polaris, where Bragg staked the Polaris claims. Bragg also found the Eclipse showing while exploring Little Cornwallis Island.

1961

Bankeno drilled nine X-ray holes totaling 160 m on the north showing at Polaris. The Polaris claims were visited by Cominco (Jim Richardson and Fred Aston), Hanna Mining (Nelson Hogg), and Texasgulf (Ken Darke).

1962

Bankeno Ltd. performed geological mapping at Polaris and Eclipse.

1963

Several short holes were drilled at Polaris, but poor results there led Bankeno to look farther afield. Bankeno staked the Eclipse claims on the eastern lobe of Little Cornwallis Island. A colour anomaly, combined with smithsonite scattered along raised beaches, indicated a large area to investigate. Bankeno undertook geological mapping and soil geochemistry on that property. Hanna Mining and Cominco competed for a chance to explore the Bankeno showings. The top three of Cominco Exploration (vice president Bob Armstrong, director Nealy Moore, and chief geologist Ron McEachern) persuaded Jack McBean, who by now was president of Bankeno, to accept a 25% carried position in an option/joint venture agreement to explore the properties on Little Cornwallis Island.

1964

Cominco obtained prospecting permits. Herb Wahl, a young geologist from the northeastern United States with Marine Corps training, carried out regional prospecting and silt sampling, focusing on areas underlain by the Thumb Mountain Formation on Cornwallis and Little Cornwallis islands. Wahl did lead and zinc mineral particle counts within 3 m radius circles on a 15 m orthogonal grid over the Eclipse area. This mineral particle survey produced anomalous areas that determined the location of 14 test pits. A Pionjar “plugger” and ammonium nitrate were used to blast craters 0.6–1 m deep in the thin felsenmeer so that the bedrock could be sampled and assayed. The Rookery and Taylor River showings were found on the basis of frost boils containing mineralization.

1965

At Eclipse, 37 short diamond holes were drilled at 15 m intervals along section lines placed 60 m apart. These drill holes (total length 704 m) intersected intermittent, discontinuous mineralization. An induced polarization (IP) survey was done over the same area during the drill program. Cominco continued regional prospecting and stream sediment sampling on Cornwallis Island, where the Stuart River and Allen Branch showings were discovered. The Allen Branch property was mapped and sampled, and the Stuart River property staked (Walrus claims) following stream sediment and soil geochemistry. Staking of claims at the Taylor River showing (the Muskox claims) was followed by soil sampling and an IP survey. Stream sediment sampling was undertaken around the Rookery showing.

1966

Nine holes (497 m) drilled at Eclipse targeted mainly the IP responses peripheral to the 1965 drill pattern. These were longer holes, some more than 60 m in length. One hole in the center of the drilling encountered some intervals of low-grade lead zinc, but most core was unmineralized. Surface work elsewhere brought some interesting results. Cominco undertook a 19 km IP survey of its Polaris claims and located an anomalous response over what is now known to be the Polaris ore body, but which at the time was thought to be a response to the erosional edge of the Irene Bay Formation. Soil sampling and mapping of the Polaris Peninsula were completed, along with 14 blast pits over the showings.

The Stuart River property was the subject of geological mapping, soil geochemistry, and 42 km of IP survey. Near midseason of 1966, it was decided to drill Zn-Pb anomalies at Stuart River. Mobilization of drill and supplies was delayed by mechanical problems and dense ground fog. Eventually three holes were collared. The first was completed, and the second and third were frozen in when drill water failed (total 115 m). At Allen Branch, detailed mapping and soil geochemistry studies were undertaken, along with 29 km of IP surveys. A regional stream sampling program was completed on Cornwallis Island. The season ended in disappointment. The final exercise was the mobilization of fuel from Resolute to Allen Branch by bombardier train for anticipated drilling in 1967. No budget was provided for 1967, and the Bankeno option was shelved before they had recovered their staking costs.

1967–69

There was no Cominco field activity on Bankeno properties on Little Cornwallis and Cornwallis islands in 1967, and the year ended with no budget for 1968 work on those islands. However, work credits would carry Cominco to the 1969 anniversary of the Bankeno agreement.

Carbonate-hosted lead-zinc activity was building within Cominco following success at Pine Point and by Cominco American in the New Lead Belt of Missouri. A senior Cominco geologist, Jack Webb, was also watching TexasGulf activity at Nanisivik on Baffin Island and talked to TexasGulf geologist Ken Darke. In August 1968, Jack Webb, concerned that the Bankeno option would expire in 1969, decided to review the project. In early September, he flew to Resolute Bay with Herb Wahl and Ted Muraro. After a one-day tour of the showings at Polaris, Eclipse, Stuart River, and Allan Branch in a Single Otter with tundra tires, the pilot left the crew at Eclipse. All of the core samples were stored in waxed cardboard trays stacked inside a roofed plywood box (3 × 3 × 2.4 m high), each corner of which perched on a 45-gallon fuel drum. The crew moved some core, slept and cooked in the core box, and got water from one of the 1964 sample craters. Muraro logged core for five or six days on a table fashioned from the door of the shack supported by two fuel drums. This mobile logging table was moved around the shack according to a choice between incident light and incessant Arctic wind. Webb and Wahl moved core in and out of the shack up and down a steep, single-plank ramp. The logging was done with no prior knowledge of the local stratigraphy.

Every hole seemed to core a different sequence of rock types, and it took several days to generate some comfort. The rock types included upper Thumb Mountain limestone, fine to medium crystalline dolomite, several types of lead, zinc and iron sulphide and oxide, and two varieties of internal sediments that fill cavities within the Thumb Mountain Formation: coarse crystalline dolomite that appeared to be a recrystallized carbonate sand and a conglomerate characterized by well-rounded carbonate pebbles.

All of the significant lead, zinc, and iron sulphides (and oxidized equivalents) at Eclipse were interpreted to rest on top of coarsely crystalline sparry dolomite and extend upward from a centimeter to more than several meters. Many of the larger mineralized intervals are truncated by the present-day surface and are partly or entirely oxidized.

This relationship between dolospar and mineralization had a big impact on the exploration model. The relationship between spar and sulphides at Duncan Lake in the Kootenay Arc had already provided insight into one style of Zn-Pb mineralization. Moreover, the literature on carbonate-hosted Zn-Pb from Illinois to Missouri talked about the temporal and spatial relationship of spar to Zn-Pb sulphides. By this time, Presqu'ile dolomite at Pine Point and the white dolomite along the Virburnum trend in Missouri were also recognized as important guides to mineralization. The evidence in Eclipse core seemed to indicate that areas of the Thumb Mountain Formation subjected to Early Devonian erosion warranted re-examination.

Muraro and Webb presented a proposal to Cominco management to revive the Arctic program with a summer of surface mapping and prospecting. Their proposal was accepted, and management went to Bankeno to negotiate for an extension of time. This negotiation was also successful, and a budget was approved for equipment and consumables to be placed on the 1969 sea lift. Tents, camp gear, two-wheeled soft-tire bikes, camp fuel, and aircraft fuel went to Resolute in late summer 1969.

During the waiting period between field seasons, Cominco geologists were able to understand the stratigraphic relationships of the Snowblind Bay and Disappointment Bay formations observed in core from Eclipse and Stuart River from the descriptions in Thorsteinsson and Fortier (1954), Thorsteinsson (1958), and Thorsteinsson and Kerr (1968). It was learned that the present-day surface on Cornwallis Island and Little Cornwallis Island is very close to the paleo-erosional surface of Early Devonian time. An exploration model was developed, which proposed that karst dissolution features created during the Early Devonian uplift were preserved and remained available to formation fluids from the basin flanking the western side of the Boothia Uplift. It was decided to map and prospect Thumb Mountain Formation for white spar. During this period, Vic Tanaka suggested that a gravity survey could help develop targets.

1970

In the spring of 1970, geologists Lynn Jones and Vic Tanaka set up a tent camp at Eclipse. Jones went to work on the core with a small rock saw and binocular microscope. The fortuitous location of the vertical Eclipse drill holes plus controlled collection of appropriate felsenmeer enabled Lynn to identify a number of distinct lithologic intervals and several markers in the Upper Thumb Mountain Formation. Tanaka upgraded the surface map and managed their communications and logistics.

The camp was moved to Polaris after two weeks. Summer students and a geophysical crew arrived. Mapping of the Polaris Peninsula provided the first look at middle to lower Thumb Mountain Formation. At approximately midslope on the Crozier Strait side of Polaris Peninsula, a prominent stratabound zone of coarse crystalline sparry dolomite was mapped northward around the nose of the peninsula to correspond roughly with the sulphide exposures of the discovery site. The 20˚E dip of the stratigraphy carried this spar zone into the ocean east of the discovery showing, near the area drill tested by Bankeno in 1961. Two additional, less spectacular, natural exposures of weathering sulphides were discovered along the crest of the peninsular ridge upslope and west of a shallow pond trapped in an erosional depression on the recessive Irene Bay Formation.

Geological mapping and prospecting teams moved to Rookery Creek, Stuart River, and Taylor River. The Allen Branch and Rookery showings were staked, and gravity surveys were completed at Eclipse (66 km), Polaris (13 km), and Stuart River (13 km). The initial gravity survey at Polaris, led by John Hales, produced a strong anomaly. During the 1970–71 winter, the survey was extended offshore to the west on the sea ice, which permitted soundings to determine the water depth necessary for best treatment of the data. Results from the gravity survey indicated a large excess mass at Polaris. Speculation filled the winter months. A drill contract was negotiated, and in spring 1971 the crews, equipment, and supplies were airlifted onto the sea ice of Crozier Strait with a Hercules aircraft. The Abbot River showings were discovered by Canadian Superior Exploration.

PHASE TWO

1971

Of the nine holes (1873 m) drilled at Polaris, only five intersected the ore body. In time it was revealed that the dolomite updip and west of the ore body was relatively barren—the original discovery showings are approximately 300 m updip of the ore body and are not connected to it by sulphides. The discovery was reported by the Northern Miner Press on 12 August 1971 as 26 m (from 126 m to 152 m below surface) at an average grade of 24.7% zinc and 5.1% lead. There was an instant infusion of money to the Arctic program and crews rushed to get regional coverage of prospective areas. The best result was the discovery by Ted Batchelor of the Truro Island showings, which were staked as the Venus claims. The Allen Branch showings were re-mapped, and 14 small-diameter drill holes (103 m) were completed. Regional mapping of eastern Little Cornwallis Island, Marshall Peninsula, and the Rookery showing was also completed. The Scoresby claims were staked on Bathurst Island by Cominco.

1972

Thirty-five surface holes were drilled at Polaris (8237 m) along with 43 km of gravity survey. An exploration adit was begun. Discovery of the Dundas Island showings was followed by geochemical sampling, mapping, and a gravity survey. Detailed mapping and a gravity survey at the Rookery showings followed up on the 1971 regional mapping results. Mapping of western Little Cornwallis Island was completed. Sixty-six kilometres of gravity survey was performed at Eclipse. Ten holes (280 m) were drilled at Truro Island along with a gravity survey and mapping. Reconnaissance work was performed by Cominco on the Grinnell Peninsula of Devon Island (Beard, Erebus, Terror, Usung, and Hecla [Sheills Peninsula] claims), on Bathurst Island, and on Ellesmere Island. A large area on Griffith Island was staked because of malachite and azurite in a carbonate conglomerate. These claims were never recorded by Cominco.

1973

The 1550 m long exploration drift was completed and used as a platform to drill 121 underground holes (6872 m). Seven holes (982 m) of surface drilling were completed. Samples of ore from the underground drift were sent for metallurgical processing. Eleven R-holes (1874 m) were drilled along the west coast of Little Cornwallis Island to test along the strike from the Polaris deposit. Truro Island was surveyed gravimetrically. The Rookery showings were gravity surveyed, and Marshall Peninsula was mapped. At Eclipse, nine holes (1227 m) were drilled to test gravity anomalies detected in previous years. Geological mapping and gravity were undertaken on Dundas Island. On Sheills Peninsula, additional claims were staked and soil geochemistry and mapping were done, and the Hornby showing on southern Grinnell Peninsula was staked. Canadian Superior Oil and Gas completed mapping, soil geochemistry, and gravity surveys on the Abbott River property.

1974

Polaris entered the mine planning stage. No further drilling was done until 1980. At Eclipse, six holes were drilled to test gravity anomalies (875 m) and an additional 119 km of gravity survey were completed. Five holes were drilled at the Truro showing (773 m), eight holes (1608 m) on the Sheills Peninsula, and two holes (306 m) at Rookery. Mapping and gravity surveys were undertaken at the Allen Branch and Taylor River showings. Claims were staked on Dundas Island by Cominco. The Grin claims were staked to cover copper mineralization in the Douro Range on Grinnell Peninsula. Canadian Superior Oil and Gas continued reconnaissance mapping and geochemical surveys and completed 11 diamond drill holes (2692 m) on the Abbott River West property.

1975

Seven drill holes (1220 m) were completed on Dundas Island. Fifteen A-series holes (1553 m) were drilled on western Little Cornwallis Island. Additional claims (the Karen claims) were staked by Cominco near the Taylor River. Canadian Superior Exploration completed 10 diamond drill holes (2092 m) on the Abbott River West property and 19 drill holes (2712 m) on Abbott River East. They also mapped and undertook a 3 km gravity survey at Stanley Head, staked the Laura and Tern claim groups on eastern Cornwallis Island to cover scattered Zn-Pb mineralization in the Allen Bay and Barlow Inlet formations, and staked the Big-G claims near Caribou Lake on northeastern Cornwallis Island.

1977

The Cape claims were staked by Canadian Superior Exploration on eastern Cornwallis Island. Mapping and soil geochemistry were undertaken on the Tern property. Kerr (1977) published his interpretation of controls on Mississippi-Valley-type mineralization in the district.

1978

Trenching was undertaken on the Grin claims on Grinnell Peninsula by Cominco. Canadian Superior Exploration did detailed geological mapping and soil geochemistry surveys on the Cape claims.

PHASE THREE

1980

Cominco renewed its regional exploration program on Cornwallis Island with an extensive geological mapping program (1:50,000 scale). Drilling was undertaken on the Taylor River property (283 m) and on the Allen Branch property.

1981

Cominco completed its regional geological mapping on Cornwallis Island. IP surveys were undertaken on the Grinnell Peninsula and Dundas Island.

1982

Mining commenced at Polaris.

1984

IP surveys were carried out at Polaris, Eclipse, and Kalivik Island. A ground electromagnetic (EM) survey was conducted at Polaris. Additional claims were staked around the Stuart River property. The GSC discovered galena on Baillie Hamilton Island (Thorsteinsson, 1984).

1986

The GSC released its map of Cornwallis Island and neighbouring smaller islands (Thorsteinsson, 1986).

PHASE FOUR

1989

Ten holes (3113 m) were drilled at Truro Island. Additional claims were staked on Cornwallis Island to cover Stanley Head, Abbott River, Eleanor River, and Bacon River.

1990

Five holes (1939 m) were drilled at Truro Island. High-voltage, current-regulating EM (UTEM) and horizontal loop EM surveys totaling 77 line km were completed on Truro Island, and a similar survey was undertaken at Eclipse. At Eclipse, 19 holes (3765 m) were drilled.

1991

Ten holes (2672 m) were drilled at Truro Island, and 31 km of IP survey were completed. Regional mapping were undertaken at Stanley Head and Rookery Creek. Cominco flew an airborne EM survey over all of Little Cornwallis Island.

1992

Drilling took place at 9 holes (2920 m) on Truro Island and 14 (3259 m) holes near the Rookery showings.

1993

The Nunavut Land Claims Agreement Act was passed.

1994

Cominco drilled 20 holes on the Abbot River East and West properties and staked claims centered near Caribou Lake on eastern Cornwallis Island. BHP Minerals staked ground on eastern Cornwallis Island and Grinnell Peninsula and began regional geophysical programs, prospecting, and silt sampling.

1995

Drilling began at the Seal showing on northeastern Somerset Island (18 holes, 3170 m). BHP was prospecting on the Grinnell Peninsula. Drilling took place at Eclipse (1318 m) in 24 holes.

1996

Gravity surveys were performed north of Polaris and in the Lee Lake area of Little Cornwallis Island, and 18 holes were attempted (777 m). The GSC discovered the Harrison showings on Bathurst Island. Five holes (888 m) were drilled at the Seal showing. Storm claims were staked by

Cominco on copper mineralization on northeastern Somerset Island, and one hole (396 m) was drilled.

1997

Three holes (891 m) were completed near Lee Lake on the western lobe of Little Cornwallis Island. Seven holes (2688 m) were drilled north of Polaris, and a grid of 75 short holes (2555 m) was drilled at Eclipse to test for metallurgical recovery. Geophysical surveys were flown over the Storm showings and 17 holes (2784 m) were drilled. Regional exploration of eastern Bathurst Island by Cominco included drilling of six holes (about 1000 m).

1998

Mapping on the Storm showings. Drilling continued on Bathurst Island (3 holes, 750 m) and metallurgical testing was done at Eclipse (16 holes, 1375 m). Noranda drilled three holes on Hornby Zn at the JG showing on Grinnell Peninsula (1022 m), and continued prospecting along the Mount Parker fault zone (JG, Trigger showings).

1999

Nunavut became Canada's third territory. Cominco drilled 3 step-out holes at Eclipse (688 m), 5 holes (900 m) on southern Bathurst Island, and 41 holes (4561 m) at Storm Copper. Drilling by Noranda on Grinnell Peninsula totaled 2351 m in eight holes. In addition, 55 km of IP, 12 km of EM, and 100 km of gravity survey were completed, and a hyperspectral airborne survey was flown over Grinnell Peninsula.

2000

Noranda acquired an interest in the Storm Copper and Seal showings and became the operator. Eight holes were drilled at Storm Copper (1450 m) and three at the Typhoon showing (537 m). Also, 2946 m in 15 drill holes by Noranda on the Grinnell Peninsula tested the Aurora, Liz, and Tiger prospects, and additional geophysical surveys were completed.

2001

Two holes (496 m) were drilled on the Stuart River property. Noranda drilled 2082 m in 17 holes and completed 160 km of gravity surveys on Grinnell Peninsula.

2002

The last ore was produced from the Polaris Mine at 01:20 on Tuesday, 3 September 2002.

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