Joseph A. Kizis, Jr.

.676461

Consulting Geologist

To: T. Kelly, D. Craig
From: J. Kizis JAK
Subject: Comments on the Golden Bear exploration program

Date: August 28, 1995

Summary and Recommendations

August 18 through 22 were spent at the Golden Bear Mine reviewing data, core, and field exposures. The geologic staff was very helpful in providing data and sharing their observations about the mineralization. The following comments are based on my review and on discussions with the Golden Bear staff; their enthusiastic contributions are here acknowledged.

The Golden Bear Mine includes the previously mined Bear Main deposit and numerous recently discovered deposits. The deposits locally contain very high grades of gold. Previous workers have classified the deposits as either Mesothermal or Epithermal; the deposits have characteristics of both environments. The deposits are hosted by Permian through Triassic limestone and metavolcanics, which have been metamorphosed to Greenschist Facies. Mineralization is localized in dilation zones within the Ophir Break, a regional system of strike-slip faults. Both ductile and brittle deformation are present. Evidence for a mesothermal ("Motherlode" -type) setting includes the structural/metamorphic setting and the presence of carbonate alteration. The geochemical suite of elements (high Au:Ag, As, Hg, Te, and F) has been sited as evidence for an epithermal setting; however, these elements are also characteristic of portions of some "Motherlode" and deep intrusive-related systems.

The current exploration program is concentrating on near-surface mineralization along the Ophir Break. This program is very well thought out and has been successful in discovering new mineralization, eg. the Ursa Deposit. Once this near surface prospecting has been completed, however, I believe that modelling the mineralization will be essential to evaluate the remaining potential of the property. Existing data is inconclusive to distinguish between the types of models that may apply; however, the necessary data can be acquired relatively cheaply. It consists of:

1. Dating (K-Ar) the pre-mineral felsic dike in the Fleece B deposit. Two samples should be collected, one relatively fresh and one mineralized. This data will provide a maximum age of mineralization. Felsic to intermediate dikes, stocks, and a large caldera occur in the region and are of Eocene age (see attached map from Bradford and Brown, 1993). If the maximum age is Eocene, mineralization would not have been derived from the surrounding rocks during greenschist metamorphism; the "Motherlode" model would not apply. An Eocene age would be consistent with either a deep intrusive-related or an epithermal model.
2. Analyzing fluid inclusions for each deposit. Examples of each pulse of mineralization should be analyzed. Hydrothermal silica is best but carbonate is acceptable. A sample of the felsic dike in the Fleece B deposit should be included. The types of fluid inclusions are generally distinctive between the different models, and analyses are relatively cheap. The cost is $10 for prep of each sample and $50/hour for examination; several samples can usually be examined per hour for this type of analysis. Analyses are done by Jim Reynolds (303-388-6583) at the following address: Fluid Inc. 3255 South Acoma Street, Englewood, Colorado, USA 80110. One or two samples per deposit should be enough to determine the appropriate model. In some replacement mineralization, however, the fluid

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inclusions are too small to be useful. If good fluid inclusions are found, temperature and pressure gradients may be identified for additional cost.

3. Analyze each deposit and areas between deposits using multi-element geochemistry. Five holes should be selected within each deposit: one in the center, one near the top, one near the bottom, and two along strike. Multi-element geochemistry should be done downhole to determine the zoning as the deposit is approached, along strike and dip within the deposit, and between the deposits. The limited multi-element data that is available suggests the district is zoned. District zoning would be evidence against a "Motherlode" model, and could provide vectors to the hottest, and best(?), portions of the system. Chemex's ICP-32 plus F and Te should be adequate analyses.
4. Compile a regional long section showing the Grade X Thickness for the entire width of the Ophir Break. Ignoring economics, we are looking for trends in total gold content in order to identify the fluid pathways. Total gold over +.5 g/t should show the patterns.
5. Compile a regional long section showing an isopach of limestone thickness. This should show structural trends and should be compared with 4 above.
6. Compile a regional long section showing trends in the multi-element data (see 3 above). This should show regional zoning and should be compared to 4 and 5 above.
7. Examine thin sections of the silicification in the deposits (eg. Kodiak A). Some areas appear to be recrystallized chert, others appear to be silicified carbonates. The chert may be an important ore channelway by forming brittle shattered zones during deformation. If so, projecting their location from mapping could predict the location of blind ore.

Miscellaneous comments from my property examination follow the discussion of deposit models below. I have also enclosed copies of numerous articles that may be of interest to your staff.

Deposit Model

Modelling the type of system that formed the mineralization at Golden Bear is important to evaluate the ultimate potential of the district, and to determine where to explore next. Table I is a summary of the three "end member" models that may apply. If a "Motherlode" system is present, mineralized pods are likely to be similar in size and grade to those already found. Deeper pods will probably not be significantly better than shallow pods. The system will probably not be well zoned. The Ophir Break will likely host many more pods along strike, although the size and grade of the pods may be somewhat different as a result of local structural conditions. If an intrusive-related system is present, mineralized pods may be significantly better with depth, and the potential would exist for a gold-rich skarn at the intrusive contact. Zoning should be well developed, which will be very helpful in developing drill targets. Additional prospecting along the Ophir Break would concentrate on identifying evidence for another system.

The role of the Ophir Break in the intrusive-related model would be as a deep-seated zone of weakness along which a pluton intruded, with its related hydrothermal system preferentially spreading out along these pre-existing structures. If an intrusive did not enter the Ophir Break, no mineralization would form. Prospecting would concentrate on sampling altered rock in the Ophir Break and determining zonation. In the case of a "Motherlode" model, the Ophir Break would be the regional-scale plumbing system through which metamorphically-derived, auriferous fluids passed. Ore shoots would form where the conditions were optimum for fluid flow and deposition of gold. Prospecting would concentrate on detailed structural analyses of the Ophir

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Break to determine fluid pathways. Much more drilling will be required to explore for this type of system than the intrusive-related type of deposit because regional zoning will not be present.

Only limited multi-element geochemistry has been done to date; however, there is evidence for district-wide zoning. The Bear Main deposit contains strongly anomalous As (.X%), and the gold occurs in arsenical overgrowths on barren pre-mineral pyrite. Total sulfides are typically +2% to 10%. Silicification is minor, and carbonate alteration is common. The Kodiak A deposit lies approximately 1.5 km to the north and is approximately 0.5 km higher in topography. The Kodiak A deposit contains much lower concentrations of As (100 to 300 ppm), and total sulfide was probably close to 1/2% prior to oxidation. Silicification is stronger and carbonate alteration is less obvious than at the Bear Main deposit. The Ursa deposit is located farther to the north of the Kodiak A deposit, and is at a lower elevation. The Ursa deposit contains very low concentrations of As (<100 ppm) but high concentrations of Hg, Te, and F (rare fluorite was observed). Silicification is common. This district wide zoning, if confirmed with additional analyses, could indicate the mineralization is related to a buried intrusive. Zoning should provide vectors to the hottest, and highest grade, portion of the system.

The newly discovered Ursa and Grizzly deposits demonstrate the merits of the current exploration program along the Ophir Break. The current program of detailed mapping, rock-chip sampling, soil sampling, trenching, and drilling should be continued northward to Sam Creek. Work to the north of Sam Creek would require new mine facilities; thus, discoveries there would not add to the life of the existing mill. After completing the current exploration program on the Ophir Break (late this season or early next season), the role of modelling will be very important. If an intrusive-related model is appropriate, zoning will be helpful in determining which deep targets should be pursued and if other structural zones should be prospected in detail. If a "Motherlode" model is appropriate, detailed structural mapping will be necessary to develop targets. In either model, the empirical observation that intersecting sine waves predict the location of mineralization (modelling the intersection of two phases of folding) may be an important prospecting guide.

Miscellaneous Comments

Sericite date: The existing sericite dates must be viewed with caution; it only dates the formation of the sericite. If the sericite existed prior to gold deposition, it would not be reset by the gold event (see Folger et al., 1995 - attached). Several examples have been recently reported in Nevada where pre-existing sericite was not reset by demonstratedly younger hydrothermal events that formed significant gold deposits; apparently the hydrothermal fluids were not hot enough to cause Argon loss and "reset" the original date. Sericite can only be used to date mineralization when the sericite formed at the same time as the mineralization, otherwise it only gives a maximum date.

Gold deposition: This is a much-debated part of all models because several mechanisms are capable of causing deposition of gold. At high temperatures (+350 degrees C), chlorine complexes are the most important complexes for gold. At lower temperatures, HS complexes are most important. The association of gold with arsenic-rich overgrowths on pre-existing sulfides at the Bear Main deposit indicates that gold was transported there as an HS complex. The very high concentrations of gold and the use of pre-existing sulfides as nucleation sites suggest the

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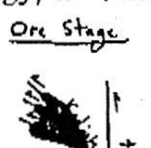
fluid was supersaturated with respect to gold, which is evidence against a catastrophic cause (such as flash boiling) for gold deposition. Gradual cooling, mixing with meteoric water, or sulfidation of wall rocks may cause a gradual decease in the solubility of gold in the ore fluid.

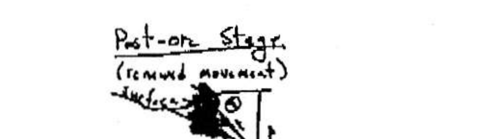
The microprobe work done on the Kodiak A deposit may provide evidence for fluid mixing: sample DH231@35.44m #6 contains a crystal of hematite enclosed in hydrothermal quartz. This shows that an oxygenated fluid was present at the site of deposition. Gold is very insoluble in oxygenated fluids; thus, the mixing of an oxygen-rich fluid with the reduce hydrothermal fluid may have caused deposition of gold. An attached abstract by Holland (1988) discusses his evidence for fluid mixing at the Tecoma deposit in Utah. An attached paper by Hofstra et al. discusses their evidence for fluid mixing at the Jerritt Canyon deposits in Nevada. Several attached abstracts from Economic Geology Monograph 6 discuss the chemistry of gold in hydrothermal fluids.

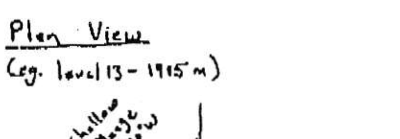
Structural controls: Structure is a very important part of every model of gold deposition. The structures determine how the auriferous fluids move from the site of their origin to sites of gold deposition, which is a large distance for most deposits. In extensional environments, the path of least resistance for the fluids is typically at fault intersections. In compressional/transpressional environments, the path of least resistance for the fluids is typically along dilational jogs. It appears that mineralization is controlled by dilational jogs at Golden Bear, and the intersecting sine wave theory should be further investigated as a predictive tool. A specialist in this type of structural geology should be consulted to provide the staff with help here.

The Ophir Break appears to be a long-lived structural zone. It may have existed long before the mineralizing event, and there is evidence that it was active after deposition of the gold. This is important in interpreting abrupt changes in grade within deposits because the deposit may not end but simply be offset. Evidence for post-mineral offset exists in the Kodiak A deposit, where the hangingwall mineralization appears to have been mostly eroded away, and in the Ursa deposit, where the hangingwall mineralization appears to have been downdropped to the west, adjacent to the footwall mineralization. The very high grades of gold often found in gouge zones suggests these faults were channelways for hydrothermal fluids, and they had renewed movement after deposition of gold.

Kodiak A deposit plunge(?): Level 13 (1915m level) and the levels above and below show an apparent plunge of the high-grade mineralization shallowly to the ~N40W (see the sketch below). The drill log for T94DH230 reports a "repeating structure" subparallel to the core axis (westerly dipping). The overall deposit appears to be hosted by a "flower" structure with probable post-mineral movement; however, other structures may have also influenced the deposit. The apparent plunge to the N40W may be: 1) a fault intersection, 2) an F2(?) fold, 3) a favorable lithology, or 4) not real.







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Au encapsulated in quartz: The Microprobe report by Cannon on the Kodiak deposit states that gold is encapsulated in hydrothermal quartz. However, the photographs are not convincing. It appears that gold in his "encapsulated" examples may actually be in small voids. The high recovery in metallurgical tests also argues against significant encapsulation. Quartz is typically early in the paragenesis of many gold systems, although it may be present in significant amounts during the main ore stage as well. Early quartz is important to many deposits because it makes the surrounding rocks more brittle; thus, more fluids are directed into areas of early silicification.

Felsic dike as an acquitard: The felsic dike in the Fleece B deposit may have acted as an acquitard to the hydrothermal fluids. The dike contains very high grade gold where cut by the ore-controlling fault, and it is unmineralized away from the fault. Similar situations have been reported elsewhere (for example, see Lauha, 1992, ...Purple Vein Deposit: Geol. Soc. Nevada, Abstr. - attached). A date on this dike would provide a maximum age for the mineralization, as discussed above.

Reverse-circulation drilling: Track-mounted reverse-circulation drilling has improved dramatically over the last few years. Larger rigs are now available in the US that can easily reach +1500'. If available in the Golden Bear area, such a rig could decrease the cost and greatly speed up the drilling process. Boosters will be necessary because of the large amounts of water present; however, when a hammer can be used, drilling can be very fast. A rate of 80-100 feet/hour is not uncommon in the upper portions of the hole in Nevada. Drilling typically slows to 40 feet/hour or less when a rock bit is used, however. These rigs do quite well in poorly consolidated alluvium, if the driller is experienced. A R.C. rig may be useful in testing shallow targets along the Ophir Break (eg. between Kodiak and Ursa deposits), pre-collaring deep core holes, and penetrating unconsolidated landslide material.

Zoning: The importance of elemental zoning has been discussed above. Often subtle zoning can be accentuated by selective sampling of mineralized structures (high grading). This also provides important information on which structural directions were open during the mineralizing event. Gold itself appears to form a halo of low-grade mineralization (0.5 to 1.0 g/t) around stronger mineralization. Elements such as arsenic, antimony, and mercury should form halos that extend outward from the low-grade gold halo.

Fluid inclusions: Attached are my notes on the use of fluid inclusions in mineral exploration from an Exxon short course that I attended in 1982. This segment of the course was presented by Jim Reynolds of Fluid Inc. Jim has provided contract fluid inclusion work to the minerals industry for quite some time now, and he has vast experience in using fluid inclusions to distinguish between various models of deposition. I discussed generalities of the Golden Bear deposit with Jim; however, I did not mention the property by name. Jim feels that if fluid inclusions are preserved, it will be a very simple matter to determine which exploration model is applicable. Detailed information such as specific temperatures and pressures of formation for use in plotting gradients would require a more detailed examination. I would submit samples as discussed above and only authorize a cursory examination of the samples. More detailed examination could be done if needed after results of other studies (eg. multi-element geochemistry) are integrated into the model.

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Table 1. Summary of deposit models that may apply at Golden Bear.

"Motherlode" Model	Deep Intrusive-related Model	Epithermal Model
1. Triassic/Jurassic age	1. Eocene age	1. Eocene age
2. No clear zoning	2. Strong zoning	2. Strong zoning
3. Structural control	3. Structural & zoning control	3. Structural & zoning control
4. Brittle/ductile deform.	4. Brittle deformation	4. Brittle deformation
5. High %CO2, Low %NaCl, High Pressure	5. Low %CO2, Higher %NaCl, High Pressure	5. Low %CO2, Higher %NaCl, Low Pressure

"Motherlode" Model - Auriferous fluids are produced during greenschist metamorphism during continental collision, and fluids are channeled along dilation zones within regional-scale strike-slip fault zones. Gold precipitates from solution as a result of fluid mixing, flash boiling of CO2, or sulfidation of host rocks. Fluid inclusions are characterized by very high CO2. Quartz veining is usually prominent, although many examples of "gray ore" exists. "Gray ore" is auriferous, sulfide-rich, sheared wall rock that is generally devoid of quartz. Examples include Angles Camp (see attached CA State Bul. # 108) and Jamestown(?) in the Motherlode of California.

Deep Intrusive-related Model - Auriferous fluids are emitted from an intrusive with variable additions of meteoric water. Intrusive rocks with granodiorite to diorite compositions are most often associated with gold-rich deposits. Gold-rich skarn may form at the contact with the causative intrusive (eg. Hedley, B.C. - See attached abstract from Meinhert's review article on gold skarns in Econ. Geol. Monograph 6), or the gold-rich zone may be separated spatially from the causative intrusive (eg. Andacollo, Chile - see attached portions of articles by Sillitoe). These systems are well zoned because of the relatively rapid pressure/temperature conditions along the fluid flow paths. Structural control of fluid pathways is still an important local ore control, however. Regional structures may control the location of the intrusive. Gold deposition may occur because of dropping pressure and temperature, mixing with cooler meteoric water, or sulfidation of wall rock. Fluid inclusions do not have high CO2 contents, and may contain high concentrations of NaCl. Calculated pressures may be relatively high, and probably grade upward to epithermal depths.

Epithermal Model - Fluids may also be ultimately derived from an intrusive source; however, the link is much less clear. Structure is a very strong ore control, particularly at the intersection of structures. Zoning is usually very strong; however, it is often difficult to use because the system migrates laterally with time as the plumbing plugs up and different portions of the fault system open up. The chemistry of the system may change significantly over time, also complicating the zoning. Gold deposition may be caused by flash boiling due to periodic fault movement, as well as the reasons listed under the deep intrusive-related model. Fluid inclusions may show evidence for boiling, multiple pulses of mineralization, and low pressures. There are many varieties of deposits included in this category, and numerous examples of these types of deposits exist all along the Cordillera. Attached articles by Arehart (1995) and Thorman et al. (1995) discuss some of the current thoughts on the formation of "Carlin" deposits.

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