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MINERAL POTENTIAL ASSESSMENT OF THE SKEENA-NASS AREA

(93E, L,M, 94D, 103G, H, I, J, P, 104A, B)

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KEYWORDS: mineral potential, Skeena, Nass, mining history, compilation, mineral assessment tracts, digital data, exploration expenditures, past production, mineral inventory, mineral occurrences.

INTRODUCTION

The Skeena-Nass project is one of seven projects comprising the Mineral Potential Initiative (Figure 1). Other areas include Vancouver Island, Cariboo-Chilcotin, Thompson-Okanagan, Kootenay, Mid-Coast and Northeast B.C. The final project, Northwest B.C., will be started in 1995. The main purpose of these projects is to produce a new series of high quality, digital mineral potential maps that can be used for land-use planning.

This report describes the general geology and mineral resources of the Skeena-Nass area and the results of the phase 1 mineral potential evaluation. An overview of the Mineral Potential Initiative, including methodology used for the phase 1 and phase 2 mineral potential assessments, is described elsewhere in this volume (Kilby, 1995).

LOCATION

The Skeena-Nass area is situated in west-central British Columbia between latitudes 53° and 57° North and longitudes 126° and 132° West (Figure 2). The project name is derived from the Skeena and Nass rivers which drain the area. The study area includes the 1:250 000-scale NTS map sheets 93E, 93L, 93M, 94D, 103G, 103H, 103I, 103J, 103P, 104A and 104B (Figure 1). The total land area is approximately 1 244 000 hectares. Major towns in the area include Prince Rupert, Kitimat, Terrace, Stewart, Hazelton, Smithers and Houston. The principle transportation routes through the area are Highway 16, Highway 37 and the Canadian National Railway.

MINING AND EXPLORATION HISTORY

The mining and exploration history of the Skeena-Nass area can be divided into three phases. The initial phase coincided with the first major influx of European fortune seekers to northwestern North America in 1889 as a result of the Klondike gold rush. A second phase was driven by mineral requirements for the Second World War. The third phase spans the period from 1965 to the early 1980s when large-tonnage porphyry deposits were the main exploration target. In recent years deposits containing gold have been the main exploration targets with several new discoveries made in the Stewart mining camp.

Figure 1. Location of the Skeena-Nass project (6) and the Mid-Coast (1), Vancouver Island (2), Cariboo-Chilcotin (3), Thompson-Okanagan (4), Kootenay (5) and Northeast (7) mineral potential projects.

The Skeena-Nass area is one of the most richly endowed parts of the province for mineral resources with 1954 mineral occurrences recorded in the MINFILE database for this area. This represents approximately 20% of the total number of occurrences in the province. Most of the occurrences contain base and/or precious metals. Of these, there are 165 past-producing mines and three current producers. The total value of past production is $7.13 billion. In-ground reserves are valued at $27 14 billion. Total exploration expenditures are estimated at $133.67 million. These values are in 1986 Canadian

dollars and were derived from data in the MINFILE and ARIS databases and from historical mining records.

Mineral occurrences within the study area cluster into specific camps as shown in Figure 2. These camps reflect the presence of important controls to mineral accumulation, for example the presence of high-level intrusions or major fracture systems. The highest incidence of deposits is clearly within the continental and island arc volcanic rocks and include a variety of deposit types genetically associated with arc development. These

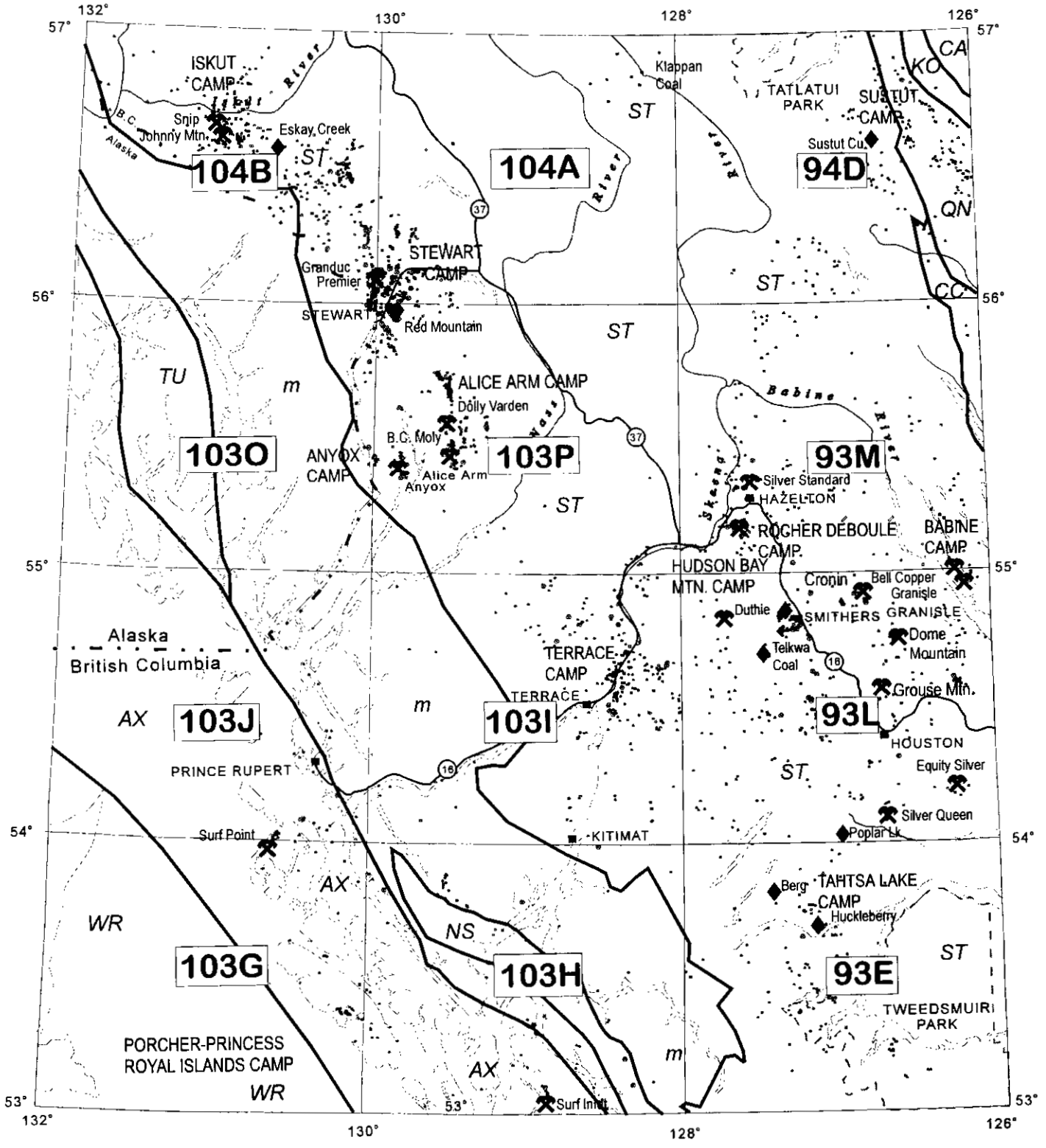

Figure 2. The Skeena-Nass project area showing NTS map sheets, major towns and transportation routes, location of mining camps and terrane boundaries. Terranes shown are Wrangellia (WR), Alexander (AX), Nisling (NS), Taku (Tu), metamorphic and plutonic rocks of the Coast Plutonic complex (m), Stikinia (ST), Cache Creek (CC), Quesnellia (QN), Kootenay (KO) and Cassiar (CA). Diamonds represent major prospects, crossed pick and shovels represent past and current producers.

TABLE 1. MAJOR DEPOSIT TYPES

Deposit Type	*Examples*
Porphyry Cu-Mo	Kitsault
	Ajax
	Hudson Bay Mtn.
	Bell
	Granisle
	Huckleberry
	Berg
	Poplar Lake
	Kerr
VMS - Besshi	Ecstall
	Anyox
	Granduc
	Eskay
Basalt hosted Cu	Sustut Copper
Epithermal Veins	Equity
	Premier
Mesothermal Veins	Dome Mtn.
	Snip
	Red Mountain
	Surf Inlet
	Surf Point
Skarns	Yreka
	Silverado
Coal	Klappan
	Telkwa

are epithermal and mesothermal veins, porphyry copper and molybdenum deposits, massive sulphide deposits, skarns and basalt-hosted copper deposits. In addition, the area has important coal resources at Klappan and Telkwa. Table 1 lists major deposit types found in the area.

GEOLOGIC FRAMEWORK

The Skeena-Nass area is part of the North American Cordillera, a broad belt of deformed igneous, metamorphic and sedimentary rocks that extends from Mexico to Alaska. The Cordillera is divisible into a number of distinct geologic terranes, many of which were accreted to the edge of the North American continent in Mesozoic time. The study area includes rocks of Wrangellia (WR), Alexander terrane (AX), Nisling terrane (NS), undivided metamorphic rocks of the Coast Belt (m), Stikinia (ST), Cache Creek terrane (CC) and Quesnellia (QN). Pericratonic and displaced continental margin rocks of ancestral North America (Kootenay and Cassiar terranes) are only found in the extreme northeast corner of the area.

A detailed discussion of the geology of the area is beyond the scope of this report. The reader is referred to published maps and reports of the Geological Survey of Canada and the British Columbia Geological Survey Branch for more geologic information. A list of selected references is included with this report.

MINERAL POTENTIAL EVALUATION

The Skeena-Nass mineral potential project was started in April 1993. Don MacIntyre, Chris Ash and Jim Britton were assigned responsibility for the geologic compilation and digital data capture; Ward Kilby and Eric Grunsky did the phase 1 and phase 2 assessments.

The key stages in the evaluation process are summarized in Figure 3. The evaluation involved *compilation of geologic maps at 1:100 000 scale*, selection of tracts based on geology, and evaluation of the potential of each of these tracts. The evaluation of mineral potential involves two phases, one based on historical data (phase 1) and one using probabilistic determinations based on expert assessments (phase 2). The methodologies used for assessing the mineral potentia of the Skeena-Nass area are similar to those used in the Mid-Coast (Bellefontaine and Alldrick, 1995, this volume), *Vancouver Island (Massey, 1995, this volume)* and Thompson-Okanagan (Church, 1995, this volume) projects.

GEOLOGICAL COMPILATION

The bulk of the evaluation process involved researching, compiling and digitizing the geology of the study area to produce an up-to-date digital geological database. Mineral tracts were defined using this database Geological compilation data for the project was released as GIS-compatible digital files in February, 1994 (MacIntyre *et al.*, 1994)

The data used for the geological compilation were obtained from existing published and unpublished sources as summarized in the list of references at the end of this report. Geological data are primarily from memoirs, papers and open file maps published by the Geological Survey of Canada, bulletins, papers, open file and preliminary maps published by the British Columbia Geological Survey, university theses and journal publications. In addition, discussions with many individuals currently or previously involved in research or exploration in the region proved invaluable.

The primary source of geological data for the mineral potential project is the 1:250 000-scale geological maps produced by the Geological Survey of Canada. They have published maps at this scale for each of the NTS map sheets covering the study area. Unfortunately there is considerable variation in the vintage and detail of mapping and this poses problems in correlating geological units across map boundaries. However, for some areas, in particular the Coast Belt and in large part the Bowser Basin, these maps are the only source of geological information.

The British Columbia Geological Survey Branch has mapped selected areas within the study area at 1:50 000 and 1:100 000 scale. Most of this mapping is recent and covers areas of known mineral potentia such as the Stewart, Smithers and Whitesail regions. In most cases, the amount of detailed geologic information contained on

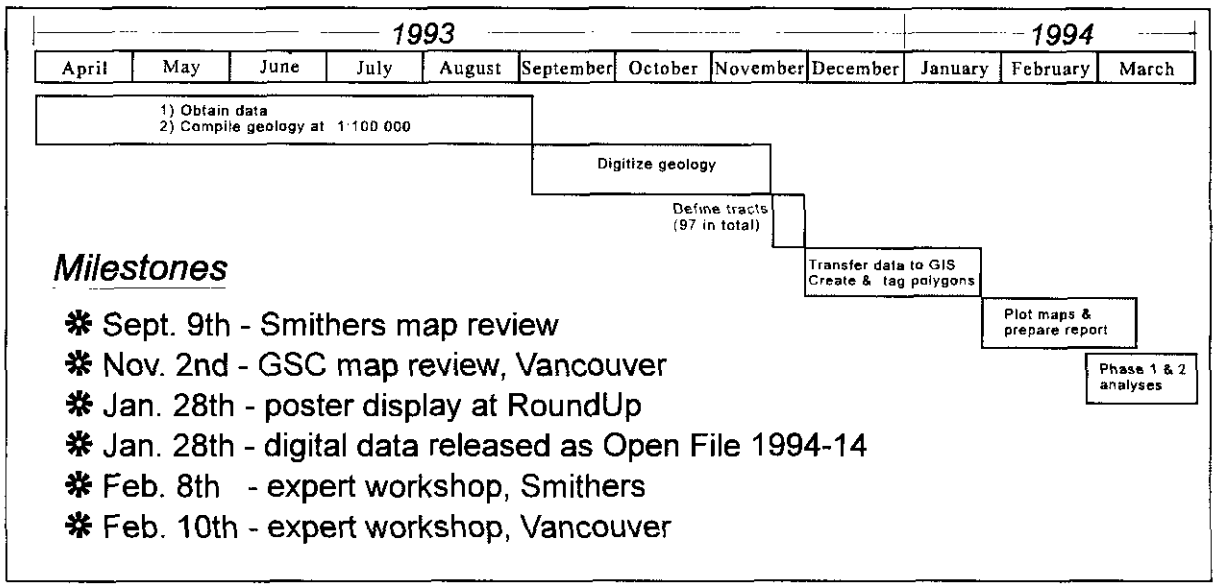

Figure 3. Time line for the Skeena-Nass project showing project milestones.

these maps was too great for a 1:250 000-scale compilation and some generalization was required.

In recent years the Mineral Deposit Research Unit (MDRU) at the University of British Columbia has conducted detailed mapping in selected mineral camps. In the study area, MDRU has produced maps for parts of the economically important Iskut River camp.

As of September 1994, there were a total of 1995 reports filed for assessment within the study area. Many of these reports contain good quality geological maps. Unfortunately most of the assessment report maps are between 1:500 and 1:5 000 scale and cover a very small area on a 1:250 000 scale map.

DATA CAPTURE

The first step for the compilation team was to compile the geology of the area onto mylar overlays registered to 1:100 000 scale topographic base maps. These base maps were generated from digital 1:250 000 scale, restructured topographic maps produced by the Ministry of Environment, Lands and Parks. In order to compile at 1:100 000 it was necessary to divide each 1:250 000 scale map area into four quadrants. A total of 38 maps were required to cover the study area.

The manuscript geology maps were digitized using AutoCad Release 12. AutoCad was used because it supports many digitizing functions which are not found in other CAD (Computer Assisted Drafting) or GIS (Geographic Information System) software packages. A digitizing strategy was used that ensured polygon closure, a key requirement if digital data are to be used in a GIS. Lines that formed polygon boundaries were placed on different layers from lines not forming boundaries. This greatly reduced the amount of editing required when the data were converted to Terrasoft GIS format.

After the maps were digitized and edited, the digital data was exported in DXF format and imported into Terrasoft using a DXF translation routine. Terrasoft was used to clean up linework, build a topology and link geology polygons to an associated attribute table. The GIS created a total of 5350 polygons, each of which was given a unique identification number by the system. Geology tags were entered manually for each of the polygons using the GIS tagging routines.

TRACT SELECTION

Mineral tracts were defined on the basis of geology and known mineral occurrence distribution. Typically, tract boundaries are defined by geological contacts - either stratigraphic or tectonic. However, in a number of cases it was necessary to place tract boundaries arbitrarily through areas of similar geology in order to reduce the size of a tract. This was particularly true for parts of the Coast Plutonic Complex and Bowser Basin.

The geological compilation maps were used as a basis for dividing the Skeena-Nass area into 97 mineral tracts (Figure 4). Individual tracts were assigned a sequential identification code based on the dominant lithostratigraphic unit within the tract (JH - Hazelton Group, CC - Cache Creek, ST - Stikine Assemblage; CP - Coast Plutonic Complex; KK - Kasalka Group; KS - Skeena Group; JB - Bowser Lake Group; PL - Lay Range Assemblage; PI - Ingenika Group; TA - Takla Group; TV - Tertiary volcanics). A list of mineral assessment tracts in order of phase 1 ranking and showing tract identification code, tract name, area in hectares, number of mineral occurrences, value of mineral inventory, total exploration expenditures, value of past production and weighted phase 1 score for each tract, is presented in Table 2.

TABLE 2. SKEENA-NASS MINERAL ASSESSMENT TRACTS - PHASE 1 DATA

Potential Class	Rel. Rank	Tract ID	Tract Name	Area (hectares)	No. of Minfile Occ	Mineral Inventory Value (1986 $)	Exploration Expenditures (1986 $)	Past Production Value (1986 $)	Weighted Phase 1 Score
HIGH POTENTIAL (33.08% of Total Area)	1	JH30	Brucejack Lake	153,982	125	8,405,910,986	19,742,757	394,193,930	4,285
	2	JH26	Alice Arm	105,619	129	2,447,448,370	5,277,323	405,426,070	4,175
	3	JH17	Hudson Bay Mtn.	35,318	50	1,241,736,544	765,033	19,177,668	4,085
	4	JH20	Newman Peninsula	84,265	19	1,957,608,942	2,476,771	1,131,845,272	4,040
	5	JH7	Tahtsa Reach	88,702	43	1,333,121,472	3,440,404	1,825 758	4,020
	6	JH29	Mount Dilworth	82,903	207	293,221,116	5,509,563	2,653,869 595	4,010
	7	JH16	Babine Range	63,037	39	229,493,710	4,335,920	4,414,286	4,005
	8	KK3	Poplar Lake	126,550	27	2,269,096,270	6,372,581	20,549,912	3,995
	9	JH31	Snippaker Creek	126,129	103	419,923,603	17,983,159	80,469 822	3,960
	10	JH25	Hastings Arm	143,526	50	1,322,569,659	2,899,007	1,409,341 250	3,915
	11	JH8	Mt. Ney	40,115	4	2,364,400,000	1,288,001	-	3,560
	12	TV4	Goosly Lake	130,523	8	153,931,000	5,005,989	739,300 933	3,425
	13	TA3	McConnell Range	125,274	83	449,000,000	2,811,832	-	3,410
	14	JH28	Mount Pattullo	147,466	80	439,430,784	6,194,186	-	3,400
	15	JH13	Grouse Mountain	73,557	31	43,404,114	1,782,282	5,766	3,385
	16	TA2	Sustut Peak	143,368	41	1,112,500,000	1,734,042	-	3,330
	17	JB3	Mt. Thornlinson	60,163	8	213,896,800	1,031,644	-	3,185
	18	JH14	Matzehtzel Mtn.	69,361	15	18,228,600	1,618,267	15,131	3,165
	19	CP11	Pitt Island	254,031	24	368,182,584	1,161,970	16,738,484	3,135
	20	CP7	Ecstall Lake	119,967	21	243,040,500	2,235,433	-	3,095
	21	CP10	Banks Island	113,185	38	110,966,171	3,158,283	-	3,070
	22	KK1	Red Bird Mtn	62,547	10	474,980,000	297,502	-	3,030
	23	JH22	Trail Peak	74,232	8	179,550,000	770,969	-	2,990
	24	KK5	*Rocher Déboulé*	76,687	35	8,091,460	607,769	7,735,236	2,975
	25	JH6	Troitsa Peak	41,327	7	34,761,230	1,297,745	-	2,955
	26	JB2	Nine Mile Mtn.	77,342	25	3,726,600	683,832	214,731	2,895
	27	CP5	Gil Island	87,287	12	9,942,387	604,882	163,424,225	2,845
	28	JH21	Netalzul Mtn.	73,151	19	3,104,163	645,726	87,478	2,835
	29	JH9	Morice Lake	152,830	16	144,727,746	2,452,547	-	2,820
	30	KS5	Smithers Landing	40,174	3	63,029,662	281,500	-	2,770
	31	JH10	Howson Range	153,085	33	153,901,000	976,526	-	2,735
	32	PL1	*Ingenika River*	44,476	8	7,938,000	1,024,012	-	2,690
	33	JB8	Sicintine Range	140,890	17	58,000,000	1,263,914	-	2,660
	34	KS3	Bulkley Valley	77,153	10	15,264,000	136,500	53,163	2,640
	35	JH24	Driftwood Range	93,208	15	32,040,000	729,747	-	2,605
	36	ST3	Iskut Mountain	288,992	34	91,014,856	2,948,979	-	2,600
	37	JH19	Zymoetz River	216,738	98	67,542,746	908,603	-	2,545
	38	KS4	Ashman Ridge	127,979	7	166,140,000	321,215	-	2,530
MEDIUM POTENTIAL (33.11% of Total Area)	39	CP3	Kemano River	102,900	5	129,195,000	311,496	-	2,520
	40	CP4	*Gribbell Island*	196,343	14	14,642,380	450,140	12,262	2,485
	41	CP1	Kimsquit River	149,912	9	51,029,861	203,022	-	2,180
	42	KS7	Kispiox River	65,343	34	-	385,341	78,268,471	1,425
	43	ST2	Newmont Lake	124,667	27	-	6,951,743	-	1,285
	44	JH12	Telkwa Range	75,662	34	-	952,964	-	1,155
	45	CP18	Terrace	84,761	37	-	981,137	-	1,130
	46	ST1	Fulton River	39,303	11	-	333,769	-	1,000
	47	JH15	Baboon Lake	82,601	10	-	907,373	-	990
	48	JB1	*Kitsumkalum Lake*	239,482	55	-	1,613,738	-	915
	49	KS11	Nilkitkwa River	41,815	1	-	584,861	-	880
	50	KS6	Skeena Crossing	88,639	29	-	346,944	-	870
	51	JH11	Houston Tommy Crk.	31,835	2	-	322,148	-	865
	52	JH5	Shelford Hills	77,768	3	-	800,720	-	850
	53	JB4	Atna Range	82,065	16	-	345,818	-	835
	54	KK2	Kasalka Range	59,580	4	-	468,639	-	810
	55	CC1	Axelgold Peak	20,683	2	-	83,698	-	740
	56	CP20	Dundas Island	98,503	30	-	135,411	-	720
	57	KS2	Round Lake	48,361	1	-	363,156	-	710
	58	CP12	Dala River	234,289	19	-	820,991	-	690
	59	JH3	Pondosy Lake	61,569	15	-	41,653	-	670
	60	JH27	Sikanni Range	114,295	9	-	206,292	-	615
	61	JH18	Telkwa River	71,838	6	-	123,110	-	610
	62	JH23	Bait Range	84,191	7	-	51,894	-	535
	63	KK4	Harold Price Creek	51,641	2	-	77,972	-	525
	64	KT2	Thutade Lake	117,111	2	-	221,421	-	515
	65	TV5	Maxan Lake	96,944	1	-	271,826	-	515
	66	JB12	Oweegee Peak	531,231	4	-	1,156,091	-	465
	67	TV3	Wisteria	122,784	0	-	445,590	-	460
	68	KS1	Thautil River	70,950	4	-	30,616	-	440
	69	CP22	Observatory Inlet	341,353	5	-	199,317	-	380
	70	JH1	Oppy Lake	52,438	2	-	5,517	-	365
	71	CP2	Kitlope River	290,135	6	-	64,138	-	355
	72	CP17	Mount Morris	94,457	1	-	54,770	-	350
	73	KS9	Nilkitkwa Lake	73,618	0	-	102,467	-	340
LOW POTENTIAL (33.80% of Total Area)	74	JB5	Hazelton Mountain	399,414	6	-	90,175	-	335
	75	TV2	Chelaslie River	80,987	0	-	110,807	-	320
	76	KS10	Takla Lake	107,864	1	-	25,000	-	315
	77	CP8	Foch Lake	128,072	2	-	2,827	-	290
	78	KS8	Gunanoot Lake	99,753	0	-	57,963	-	270
	79	JB10	Lipsconesit Mountain	958,829	2	-	183,662	-	260
	80	CP16	Kateen River	233,277	2	-	5,921	-	250
	81	JB7	Kispiox Range	288,960	1	-	28,038	-	245
	82	CP19	Work Channel	52,157	4	-	-	-	230
	83	JH2	Butler Peak	41,006	3	-	-	-	220
	84	TA1	Mesilinka River	30,388	1	-	-	-	160
	85	JB11	Devils Claw	244,250	8	-	-	-	155
	86	CP21	Khutzeymateen	35,888	1	-	-	-	150
	87	CP6	Ecstall River	208,830	5	-	-	-	145
	88	CP15	Quottoon Inlet	128,082	2	-	-	-	115
	89	CP9	Crab Lake	195,024	3	-	-	-	110
	90	KT1	Connelly Range	163,040	2	-	-	-	95
	91	CP13	Alastair Lake	102,880	1	-	-	-	80
	92	JB6	Swan Lake	224,951	1	-	-	-	60
	93	JB9	Mosque River	146,830	0	-	-	-	-
	94	JH4	Quanchus Range	166,912	0	-	-	-	-
	95	TV1	St. Thomas River	82,190	0	-	-	-	-
	96	CP14	Mount Salvus	33,781	0	-	-	-	-
	97	PI1	Tucha Range	51,187	0	-	-	-	-
				12,438,760	1954	27,145,732,316	133,696,593	7,126,969,443	157,770

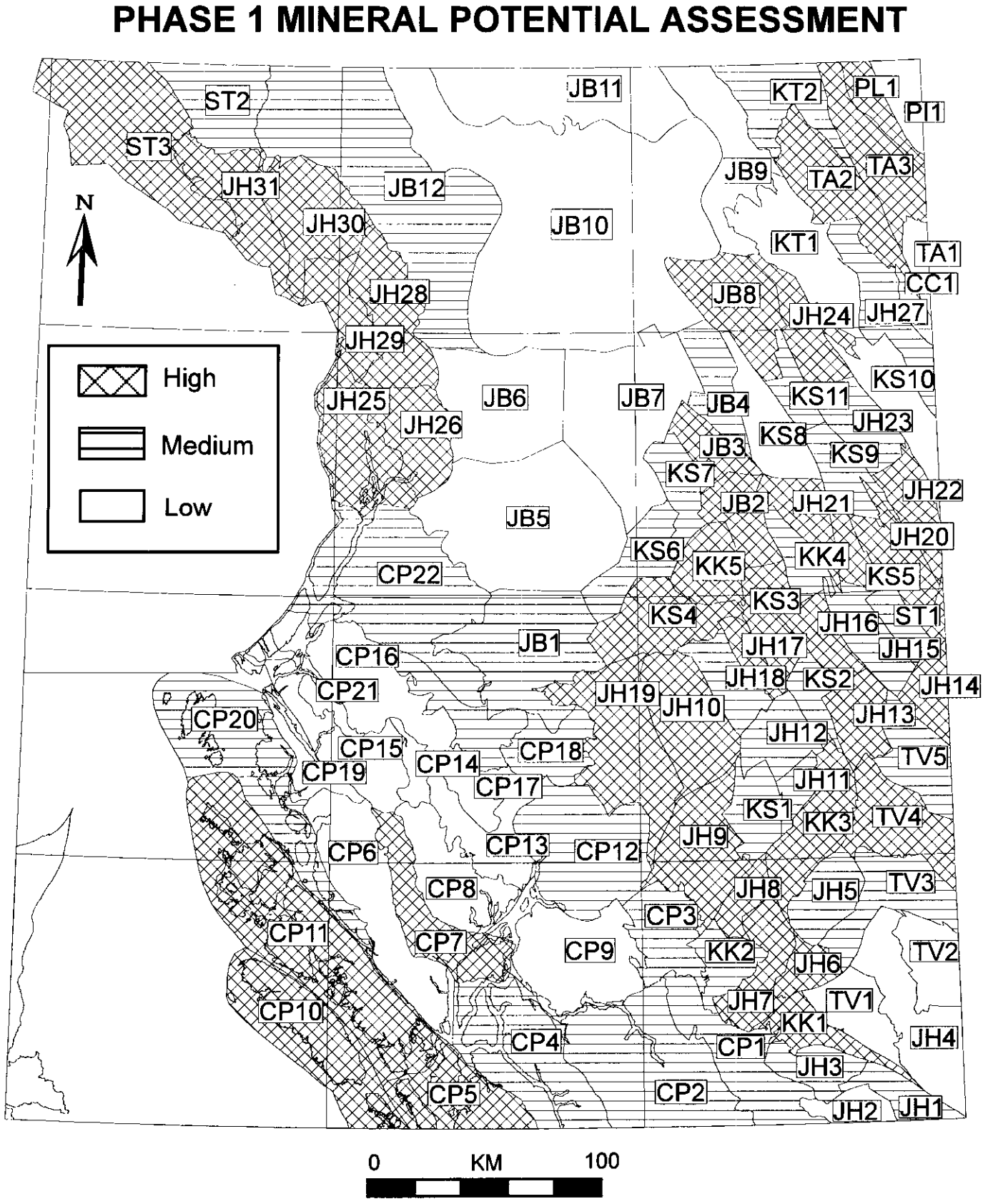

Figure 4. Skeena-Nass mineral assessment tracts showing tracts ranked high, medium and low in the phase 1 assessment.

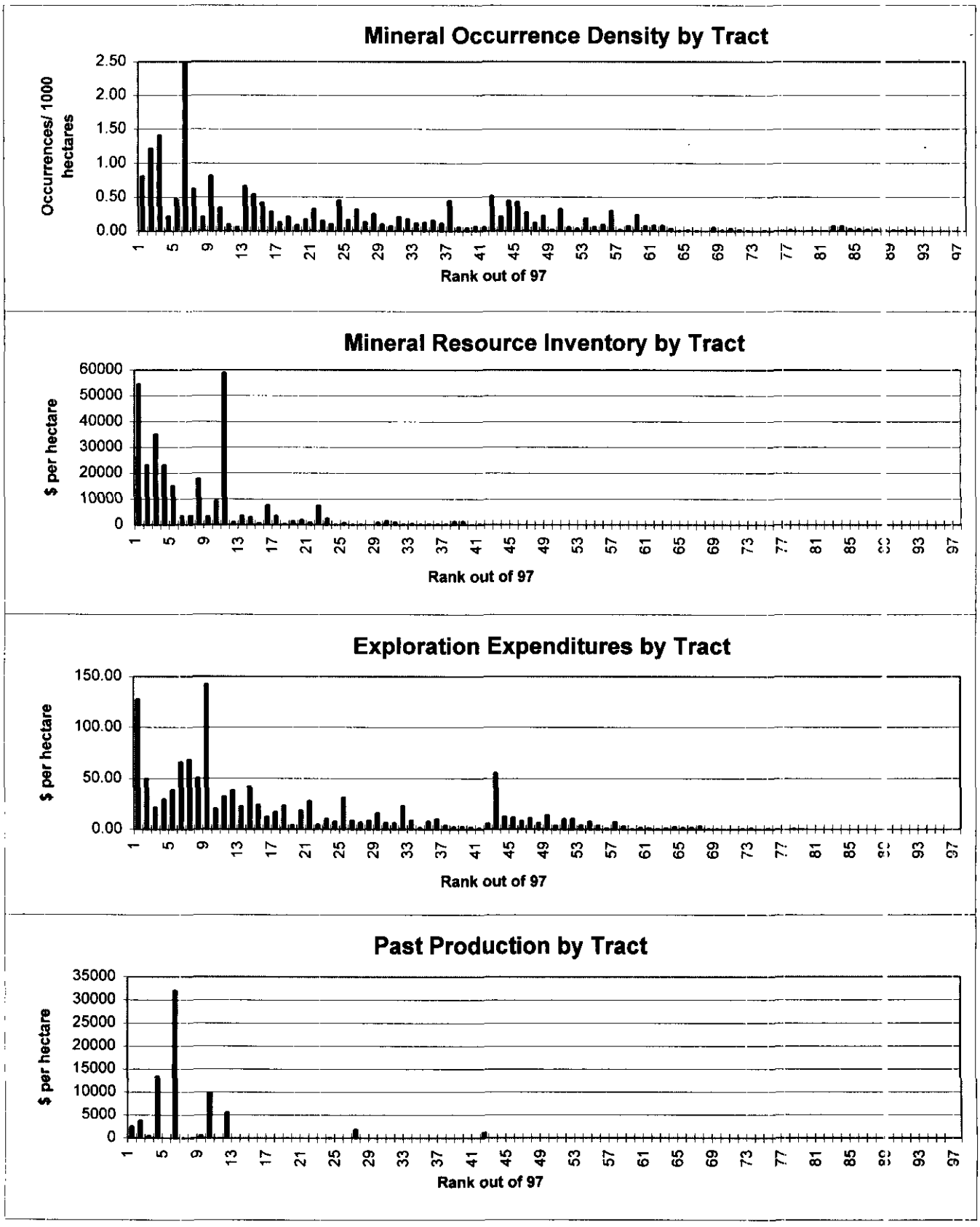

Figure 5. Bar graphs of phase 1 mineral assessment data normalized to tract area and ordered by rank.

PHASE 1

The phase 1 mineral potential assessment is based on the mineral occurrence density, value of past production, previous exploration expenditures and value of known in-ground "reserves" for each tract as described elsewhere in this volume (Kilby, 1995). The score shown in Table 2 is calculated by ranking each tract according to these factors relative to tract area, and then applying a weighting factor to the resultant ranks and adding the results. The weighting factors are 25 for known resources, 10 for past exploration work and 5 for number of mineral occurrences and past production. The tracts are then given a rank from 1 to 97, with 1 being highest potential and 97 lowest. The per hectare values calculated for each tract and arranged by rank out of 97 are shown graphically in Figure 5. This ranking is specific to the project area only and does not relate to ranks assigned in adjacent areas (*e.g.* Mid-Coast). Tracts ranked low in the Skeena-Nass area may still have significantly higher mineral potential than those in adjacent areas that are not as well endowed with mineral deposits. A low rank does not imply no mineral potential, only relatively low potential by comparision with other tracts in the project area.

After a phase 1 ranking has been determined, the tracts are then divided into groups representing high, medium and low potential based on cumulative area. In this way tracts representing the top 33.08 % of the area (4 115 143 ha) are assigned to the high potential category, the next 33.11 % (4 119 066 ha) are considered medium potential and the bottom 33.80 % (4 204 551 ha) are considered to have low potential (Table 2).

Figure 4 shows the distribution of tracts in the area with a shading pattern reflecting high, medium and low potential. The highest ranked tract (JH30) is in the Stewart area and contains the Eskay Creek deposit; the lowest ranked tract (PI1) is in the extreme northeast corner and is underlain by unmineralized Proterozoic rocks. In general, tracts containing volcanic rocks of Triassic, Jurassic and Cretaceous age are ranked medium and high while those containing successor basin sedimentary rocks (Bowser Lake Group) or large unmineralized plutons such as those of the Coast Plutonic Complex are ranked low.

PHASE 2

The phase 2 estimation process is designed to identify tracts with potential for undiscovered mineral deposits. The estimates are done by experts with personal knowledge of the area, and, when combined with the phase 1 results give an overall ranking for the mineral potential of a given tract. The phase 2 estimates take into account previous levels of exploration and current deposit models that may not have been the focus of previous exploration efforts. In this way, tracts with favourable geology but no known production or reserves can often be ranked higher than tracts which are considered to be well explored and to have less potential for new discoveries.

Expert estimation for the phase 2 mineral potential assessment were completed for the Skeena-Nass project in February, 1994. Unfortunately, the number of estimators participating in the process was relatively low. Consequently, not all tracts and deposit types were considered by the estimators and it may be necessary to conduct a new set of estimates using a revised methodology.

DISCUSSION

The phase 1 rankings clearly reflect the weighting criteria used to score the tracts. Well explored areas with known reserves and historical production are the top ranked tracts; tracts with no known occurrences and no previous exploration or production history score very low. Tract size can also be important because scores are based on per hectare values not total values. A small tract with numerous occurrences and historical reserves will score higher than larger tracts with similar values.

A complete assessment of the mineral potential of the Skeena-Nass area must await completion of the phase 2 assessment. Although useful as a guide to areas of favourable mineral endowment, the phase 1 assessment does not by itself, address the potential for undiscovered deposits. This information is required before a final mineral potential map and report can be produced for the project.

ACKNOWLEDGMENTS

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