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NORWAY PROJECTS REVIEW

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Prepared For:

Diamond Fields Resources, Inc.
9th Floor, 200 Burrard Street
Vancouver, B.C. V6C 3L6 Canada

Prepared By:

Boye Flood
Geologiske Tjenester a.s.
Hovfaret 8
0275 Oslo, Norway

and

Thomas L. Robyn, Ph.D.
ST Group, Inc.
1551 Prairie Owl Road
Parker, CO 80134 USA

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INTRODUCTION: Evaluation of Diamond Fields Resources' Norwegian properties was done during October, 1995. Three properties were visited by foot traverse, automobile and helicopter, and preliminary sampling was done. Locations of the three properties are shown in Figure 1. The main objective of the evaluation was three-fold: 1) confirm that the geology and mineralization in the areas were as reported; 2) determine the potential for significant nickel deposits to occur in each of the areas; and, 3) determine the suitability of the areas for airborne geophysical surveys.

The Evje-Iveland and Ognå-Egersund areas contain nickel deposits and occurrences hosted in mafic intrusive complexes, and are recommended for airborne surveys directed at locating feeder systems which contain massive nickel-copper deposits. Additional ground work on the Flakstad area is recommended prior to a decision about an airborne survey there. However, because the area is small and an airborne tool will be in the country for the surveys in south Norway, Flakstad could also be flown in 1996.

The three areas are described below, and recommendations and budgets given for exploration to be done during 1996.

EVJE-IVELAND: The Evje-Iveland property covers 117 km², and is held by 390 mutinger (pre-claims; Figure 2). This area, in south-central Norway, is the highest-priority property and is underlain by Middle Proterozoic (ca. 1,700 m.y. old) gabbro, amphibolite, hornblende diorite and ultramafic rocks which were intruded into amphibolite-facies, granitic and dioritic paragneisses (Figure 3). The Evje-Iveland complex was intruded where deep crustal structures occur, as shown by regional geologic and magnetic data.

The structural setting is only one of the similarities that Evje-Iveland has with respect to Voisey Bay, which apparently has the following major ore-forming controls: 1) the Nain mafic complex was intruded along a major crustal boundary, where Proterozoic and Archean terranes are juxtaposed; 2) the mafic magmas rose through thick, sialic crust; 3) multiple intrusions occurred and resided at deep, crustal levels; 4) the Reid Brook magmas interacted with surrounding rocks to become sulfur-saturated and precipitate nickel-copper sulfides; and 5) feeder

zones become enriched in sulfide liquids which subsequently settled into them.

The age of the Reid Brook intrusion, about 1.3 billion years, is important in that it demonstrates that the Nain magmas were not intruded until the Earth's crust had become greatly thickened. Therefore, any mafic complex with similar features could host another Voisey Bay deposit, even if it is 1.7 billion years old or 600 million years old. By this concept, Voisey Bay-type deposits are unlikely to occur in Archean complexes, but could occur in any mafic complex younger than about 1.8 billion year that intruded a sialic-crustal setting.

At Evje, similar controls are present: 1) the 1.7 billion-year-old Evje-Iveland complex intruded near a major shear zone separating two distinct types of crust; 2) the magmas rose through thick, sialic crust; 3) multiple intrusions occurred at deep, crustal levels, as evidenced by deformation concurrent with intrusion; and, 4) the intrusions appear to have reacted with surrounding gneisses, with the result that many nickel occurrences are present in the complex.

Norway's largest nickel deposit, the Flåt mine, is hosted by the youngest intrusion of the complex, a hornblende diorite. This underground mine operated from 1872-1945, except for the years 1984-99 and 1920-27, and produced about 2.7 million tonnes of ore averaging 0.72% Ni and 0.48% Cu. It is interesting to note that *the ore only averaged 12-13% sulfides*. What would the nickel and copper contents have been if the sulfide minerals occurred as massive sulfide mineralization?

Cobalt was a by-product but average ore values were not reported; Co contents in pyrite from the mine ranged between 0.6% and 1.0%, but the amount of pyrite in the deposit is not given. The mine was exhausted in 1945. Concentrates were processed at Falconbridge's nickel smelter in Kristiansand, 65 km to the south, which is still in operation and processing nickel matte from Canada.

The host diorite is massive and not foliated like many of the older rocks of the complex. It was emplaced in the final stages of intrusive activity, and was "especially enriched in sulphides" (Bjørlykke, 1947). The ore was very different in different parts of the ore body. Lumps of ore mined differ in composition

from nearly 100% sulfides to dioritic rocks only slightly impregnated with sulfides. The only primary sulfide minerals in the nickel-copper ore are pyrite, pyrrhotite, pentlandite and chalcopyrite. Pyrrhotite always occurred together with pentlandite, and they were intimately intergrown and impossible to separate.

Other nickel occurrences are hosted in the Evje mafic rocks; 22 are known (Figure 3). The known occurrences are in two clusters 8-10 km apart. The Flåt mine is located in the northern cluster and is hosted by quartz-hornblende-andesine diorite in hornblende gneiss which exhibits a magnetic high. Most of the occurrences in the northern cluster are hosted by amphibolite. The southern cluster also lies within a magnetic high, and is hosted by a mixture of gabbro and amphibolite. The two clusters of nickel occurrences are separated by an area of lesser magnetic response. The Evje-Iveland area is extensively covered, and is classic shield terrain (Photo 1).

The immediate vicinities of four of these were explored by electric measurements and drilled with no success (Nixon, 1975). Subsequently, Sulfidmalm (Norwegian subsidiary of Falconbridge) conducted exploration in the region, also without success. There is no evidence that Sulfidmalm conducted an intrusion-wide exploration program. Instead, they focussed closely on already-known nickel occurrences.

The Flåt mine and several nickel occurrences were visited during this evaluation, but only Mølland and Orreknappen will be mentioned because these are the most definitive. At Mølland, the host rock is coarse-grained gabbro. Prior to WWII a small shaft was sunk with about 50 meters of drift. In addition, 18 holes totalling 888 meters were drilled. Blocks of semi-massive sulfide are seen in a dump at the Mølland shaft, but most of the mineralization occurs as sulfide disseminations. Pale purple plagioclase is common. Sulfide minerals include pyrrhotite, chalcopyrite and pentlandite. Euhedral sulfide crystals which contain both pyrrhotite and chalcopyrite are common (Photo 2), indicating exsolution of the minerals from a single precursor crystal. Also, rounded blebs of pyrrhotite and pyrrhotite-chalcopyrite are common, and are inferred to represent chilled globules of sulfide liquid. These textures are similar to those seen in the Reid Brook pluton.

Table 1 shows that a sample from Mølland assayed 0.74% Ni and 6.87% S ($S/Ni = 9.3$). The Ni contents were recalculated by A. Naldrett (see Appendix 1) to 100% sulfides, which resulted in a recalculated Ni content of 4.12%.

Mølland was explored by Sulfidmalm during 1969-70, who drilled 12 holes totalling 1945 meters (refer to Appendix 2, B. Flood's core review). This work and the pre-WWII work was done over a strike length of about 350 meters. Disseminated sulfide mineralization is wide-spread in these holes, with intercepts of, for example, 63 meters averaging 0.30% Ni (including 6.8 m at 1.04% Ni; hole 9/70), and 33 meters of 0.28% Ni (hole 7/70). The S/Ni ratio in the 6.8 meter interval is 2.9/1.0.

Magnetic and EM surveys did not outline this disseminated mineralization, but IP appeared to be a good method to define the zone. However, Sulfidmalm's IP survey was not done until after the drill program. It appeared that the best IP targets had been drilled, based on geology, but that a similar target extended northwards for another 200 meters.

Magnetic susceptibility measurements were made on the core by Boye Flood using a Scintrex SM-5 meter with 10^{-3} cgs units. Where Ni mineralization is about 1% the core exhibits susceptibility between 0.7 and 2.8, and contains disseminated and stringer sulfide mineralization which may produce a weak conductor.

From these observations, it appears that a combination of weak-to-moderate conductors and medium magnetic anomalies will indicate deposits with nickel contents of 2-3% Ni. A moderate-to-strong conductor and medium-to-strong magnetic anomaly may indicate a deposit with up to 4% Ni, the value indicated by recalculation mentioned above.

The Orreknappen occurrence has several small dumps containing material excavated from a single adit. The host rock is amphibolite with varying percentages of actinolite, biotite, quartz and plagioclase (see Appendix 3; petrographic descriptions by A. Naldrett). Disseminated to semi-massive pyrrhotite in the amphibolite contains pyrite, chalcopyrite and pentlandite. Ni contents are lower

ASSAY RESULTS, NORWAY SAMPLES

Sample #	Location	Rock Type	Cu ppm	Ni ppm	Co ppm	Fe %	S %	Zn ppm	Pt ppm	Pd ppm	Au ppm	As %
LOFOTEN												
9511 955	Flakstad	norite	143	27	20	8.90	0.40	12	<0.01	<0.005	<0.01	0.003
9511 956	Flakstad	norite	48	17	10	7.20	0.21	8	<0.01	<0.005	<0.01	<0.001
9511 957	Flakstad	norite	40	11	13	5.90	0.15	9	<0.01	<0.005	<0.01	<0.001
9511 961	Flakstad	mangerite	139	4	19	8.30	0.41	25	<0.01	<0.005	<0.01	<0.001
9511 962	Flakstad	norite	105	14	6	5.60	0.24	6	<0.01	<0.005	<0.01	<0.001
9511 963	Flakstad	gabbro	122	32	22	7.90	0.26	12	<0.01	<0.005	<0.01	<0.001
9511 965	Flakstad	gabbro	59	33	39	9.00	0.33	36	<0.01	<0.005	<0.01	<0.001
OGNA-EGERSUND												
9511 966	Homse	norite w/ sulfides	8100	6300	900	32.00	32.26	60	<0.01	0.005	0.04	<0.001
9511 969	Homse	norite w/ sulfides	28000	1200	700	13.60	11.51	101	0.01	<0.005	0.05	<0.001
9511 971	Knuten	norite w/ sulfides	1730	3700	230	11.90	8.75	12	0.01	0.018	0.02	<0.001
9511 972	Knuten	pyroxene gabbro	970	1110	30	3.50	1.36	22	<0.01	<0.005	0.01	<0.001
EVJE-IVELAND												
9511 973	Flaat mine	diorite w/ sulfides	6700	4900	510	13.80	8.94	232	0.04	0.016	0.20	<0.001
9511 974	Soeraana	pyritic diorite	860	220	220	23.00	15.37	53	<0.01	0.007	<0.01	<0.001
9511 975	Klepptjarn	pyritic hornblendite	710	350	90	3.70	2.08	14	<0.01	0.005	0.01	<0.001
9511 976	Klepptjarn	pyr. UM & hornblendite	720	1220	60	3.00	0.81	16	<0.01	0.049	0.01	<0.001
9511 977	Moelland	gabbro w/ cpy and po	3500	7400	280	10.10	6.87	30	0.03	0.074	0.04	<0.001
9511 978	Orreknappen	amphibolite w/ cpy+po	6000	5300	600	23.00	17.16	62	<0.01	0.043	0.05	<0.001
9511 979	Orreknappen	amphibolite w/ cpy+po	2500	11600	700	38.00	30.26	17	0.03	0.090	0.01	<0.001

TABLE 1

than at Mølland, the highest recalculated value being 1.48%. Pentlandite occurs as flames in pyrrhotite, a texture which also occurred in the Flåt ore.

A number of ground geophysical surveys were tested over this occurrence and the Bekken occurrence 400 meters to the north. Concurrent mapping showed abundant pegmatites around Orreknappen, and Bekken produced the best EM anomaly with a strike length of 100 meters. This anomaly was tested by 3 Winkie holes totalling 30 meters, which penetrated disseminated to semi-massive pyrrhotite, pyrite and chalcopyrite mineralization. Nickel content was stated to be low.

Work done during previous exploration shows that nickel mineralization in the Evje-Iveland complex is wide-spread and has a wide range of assay results. The known occurrences crop out in resistant rocks which stand above the surrounding, heavily-vegetated, shield-like terrain. The Flåt mine was discovered because a narrow zone of mineralization cropped out on a low hill underlain by resistant diorite.

It is expected that large bodies of high-grade nickel mineralization will not be exposed, but will be covered by lakes or bogs.

Recommendations: Because exposure is poor in the complex and there has never been any exploration done over the entire complex, the Evje-Iveland area is a good target for an airborne geophysical survey which would be directed at locating high-grade nickel deposits in feeder systems for the complex. The flat, shield-like terrain is suitable for the survey to be done by fixed-wing aircraft.

An airborne survey is recommended to be flown during May, 1996. A survey of 570 line-kilometers would cover the entire complex. Ground follow-up would be done during May-June, and might include limited geophysical surveying. However, it is expected that the location of conductors will be so well known that little if any geophysical follow-up would be required. The main objective of the follow-up work is to locate conductors on the ground and examine the vicinity for mineralization or cultural causes for them, sample any mineralization or alteration present, and map the vicinity in order to identify the host rock.

Another factor is to determine access to each conductor in the event that it is selected to be drilled.

Data compilation and interpretation for both the geophysical and geological surveys will be done over the summer, and drill sites selected. Drilling of several targets is anticipated for September, 1996. A total of 3,000 meters of drilling is projected, at a cost of \$Can90/meter in direct drilling costs and \$Can20/meter for logging, splitting and assaying the core, for a total drilling cost of \$Can110/meter.

Final reporting will be done during November, 1996.

Budget: The estimated budget for the Evje-Iveland project is:

	<u>\$Can</u>	
Airborne geophysical survey:	70,000	
Permits & Follow-up:	30,000	
Drilling:	330,000	
Helicopter support:	77,000	
Reporting:	3,000	
Travel & Misc.:	20,000	
1996 claim fees:	<u>62,000</u>	
Total: \$Can 592,000		2,699,520,-
\$US 455,000		

OGNA-EGERSUND: The Oгна-Egersund property covers 148.5 km², and is held by 495 mutinger (Figure 4). This area on the southwestern tip of Norway is underlain by the Rogaland intrusive masses (Photo 3), which contain large volumes of anorthosite, norite and related rock. An area 60 x 25 km contains several massifs of these 1000-1300 m.y. old rocks (Duchense and Michot, 1987). The Rogaland massifs occur where deep, NW-trending crustal structures cut the southwestern edge of Norway. Drilling for oil has penetrated a down-faulted portion of the complex 20-30 km offshore, but the total extent of it is unknown. The oldest massif of the complex, the Egersund-Oгна massif, contains several nickel-copper occurrences. While Ni-Cu sulfides are found in the other massifs, they are very low grade and associated with ilmenite deposits.

The Oгна-Egersund massif (Figure 5) is composed of an anorthosite-leuconorite dome, approximately 20 km in diameter which was emplaced in granulite facies paragneisses. Noritic dikes cut the foliation of the massif; foliation resulted from deformation concurrent with emplacement. A homogenous, faintly-foliated leuconorite is an important phase of the massif. It is grossly concentric with the core and at an equal distance from the margin. Relatively-high Cr contents in orthopyroxene indicate a basaltic composition for the parent magma.

The Rogaland massifs have several similarities to Voisey Bay. These similarities include: 1) the complex was intruded along a major crustal fault, which extends from off-shore Norway, across Sweden and into Poland; 2) the magmas rose through a thick, sialic crust; 3) the magmas resided at deep, crustal levels, as evidenced by the large norite crystals which reach up to 3-4 cm in size; and, 4) the magmas appear to have reacted with the surrounding paragneisses, as evidenced by several nickel occurrences.

The Oгна-Egersund land position covers the northwestern portion of the Rogaland massif. The property includes the area's largest nickel occurrence, Homse, which was test-mined on a small scale in 1871 and 1915 but had no production. Ore occurs as a lode in brecciated anorthosite and dips steeply. Field examination of the occurrence indicates that it could be a xenolith torn from depth and carried to its present position by the brecciated intrusion. The extension of the deposit is not known because of extensive cover in the area, but available

geophysical data indicate that it is of limited extent. The "ore" is compact nickel-pyrrhotite with some chalcopyrite, and reported to contain 1.06% Ni and 1.20% Cu. Table 1 shows that samples collected at the Homse dumps assayed 0.81% Ni and 2.8% Cu, which is similar to the reported grades.

A helicopter-borne electro-magnetic survey was flown by Terratest in 1972, and Homse deposit exhibited an EM response. The survey only covered 5 km². The tool type is not known, but probably was VLF (see below). Apparently, no systematic exploration for nickel has been done in the covered areas in the massif hosting the Homse deposit.

The survey also located a larger response 700 meters east of Homse, which is called the Bjørndalsnipa occurrence (Sverdrup, 1972). There is no surface expression of this occurrence, even though it lies only 20-30 meters below the surface. The occurrence is in an area of multiple, cross-cutting, coarse-norite intrusions (Photo 4).

Three holes were drilled on the Bjørndalsnipa anomaly in 1973, and two penetrated pervasive nickel-copper mineralization with grades similar to Homse (Mørk, 1974). The first hole was drilled on a VLF anomaly and mag low, and was barren. Hole 2 was drilled 30 meters to the east of #1 and encountered pervasive nickel mineralization at only a few meters depth, with 4.45 meters of 0.62% Ni, 0.28% Cu, and 7.3% S (see Appendix 2, Boye Flood's notes on the core logging for assay sheets). Hole 3, which was drilled on the southern gradient of the VLF anomaly drilled in #1 but on elevated mag, also encountered significant nickel mineralization, with grades up to 1.06% Ni. The VLF anomaly has an E-W strike of at least 200 meters, but was drilled by two holes only 30 meters apart. The zone of sulfide mineralization may actually be larger, because VLF has poor depth penetration and may not have detected deeper portions of the conductor.

Sydvaranger's country-wide nickel exploration program was terminated before additional work could be done.

Recommendations: The success of Terratest's limited survey in locating the Bjørndalsnipa occurrence indicates that a survey over the entire Ognå-Egersund intrusion is very likely to locate other conductors because there has never been any exploration done over the entire complex. As at Evje-Iveland, the airborne geophysical survey will be directed at locating high-grade nickel deposits in feeder systems for the complex. The survey could probably be done with fixed-wing aircraft because the target area is not excessively steep. A review of topographic maps should be done before this decision is finalized.

From the results of Terratest's survey, combined mag-EM anomalies would be drill targets.

An airborne survey is recommended to be flown during May, 1996, and would probably be done before the survey at Evje-Iveland because Ognå is at a lower elevation. A survey of 650 line-kilometers would cover the entire noritic portion of the Ognå-Egersund complex, and some of the anorthositic portion. Some areas of the massif are not suited to geophysical surveys because of intensive cultural interference, but the area recommended for survey has limited interference.

Ground follow-up would also be done during May-June, and might include limited geophysical surveying. However, it is expected that the location of conductors will be so well known that little if any geophysical follow-up would be required.

The main objective of the follow-up work is to locate conductors on the ground and examine the vicinity for mineralization or cultural causes for them, sample any mineralization or alteration present, and map the vicinity of their vicinity in order to identify the host rock. Another factor is to determine access to each conductor in the event that it is selected to be drilled. Because of the lack of roads in the noritic portion of the complex, a drill rig would probably have to be slung in by helicopter.

Data compilation and interpretation for both the geophysical and geological surveys will be done over the summer, and drill sites selected. Drilling of several targets is anticipated for September, 1996. A total of 2,000 meters of drilling is projected, at a cost of \$Can90/meter in direct drilling costs and

\$Can20/meter for logging, splitting and assaying the core, for a total drilling cost of \$Can110/meter.

Final reporting will be done during November, 1996.

Budget: The estimated budget for the Ognå-Egersund project is:

	<u>\$Can</u>
Airborne geophysical survey:	80,000
Permits & Follow-up:	30,000
Drilling:	240,000
Helicopter support:	51,000
Reporting:	3,000
Travel & Misc.:	3,000
1996 claim fees:	<u>82,000</u>

Total: \$Can 489,000 2.229.845,-
\$US 376,000

Approval for the program should be given in February at the latest, in order to obtain contracts and permits for the survey on a timely basis. Note that the low travel cost for this project is based on the assumption that the Evje and Ognå projects will be done concurrently.

FLAKSTAD: The Flakstad property covers 34.2 km², and is held by 119 mutings (Figure 6). The property is in the Lofoten Islands located off the coast of Norway, southwest of Narvik, which are underlain in part by a large, 1800-2200 m.y. old, anorthosite-troctolite-mangerite-charnockite complex (Figure 7) covering about 3,000 km². The complex is associated with a major gravity anomaly, with a 100 mgal anomaly under the islands. The Lofoten complex occurs along a major crustal boundary, which separates Archean and Proterozoic terranes. Nd isotope data indicate significant crustal interaction with the Lofoten magmas.

On the southwestern border of the complex, a sequence of early(?) gabbro, norite, anorthosite and troctolite is exposed over an area of about 10 x 2 km. No sulfides or nickel occurrences are known to be associated with these border rocks, and the more felsic portions of the intrusion further northeast contain several ilmenite occurrences and one nickel occurrence. Relief is spectacular, with 500 meters of relief occurring over distances of only a few hundred meters (Photos 5 & 6). The region has been the subject of exploration on-and-off over the past 20 years, and exposure is good.

The Flakstad land position covers the anorthosite-troctolite portion of the complex. Samples collected during the October trip confirm these rock types, and show that some norite is included in the troctolite map unit (see Appendix 3). The presence of green spinel in the rocks also demonstrates some crustal contamination of the magmas, which is consistent with the Nd data. Also, nickel contents are very low in the mafic portion, indicating possible fractionation of the magmas with later stripping of chalcophile elements by interaction with sulfide. According to Naldrett (Appendix 1), the geochemical data are "moderately, but not strongly indicative that a deposit may be in the vicinity".

The Lofoten intrusions have several similarities with Voisey Bay. These include: 1) the complex lies along a major crustal boundary; 2) the magmas rose through thick sialic crust and interacted with the crust; and, 3) the magmas resided at deep crustal levels as evidenced by the presence of purple plagioclase in the troctolite.

Recommendations: The presence of troctolite in a mafic-to-felsic intrusive complex at a major crustal boundary indicates that additional work is warranted on the property. Geochemical data are moderately supportive of a possible deposit in the vicinity.

A geochemical evaluation of the complex should be done. This would include microprobe studies and Sm-Nd determinations on samples collected this year. Additionally, a brief helicopter-supported reconnaissance over the mangerite-charnockite portion of the complex should be done to confirm that no further mafic portions are present. This recon could be done in June, after the follow-up work is completed on the southern Norway projects.

Because the land position is small, it would not be expensive to conduct an airborne geophysical survey over it. This could be done while a survey tool is in the country for the surveys on the Evje and Oгна properties. A helicopter-borne survey is necessary at Flakstad due to the area's relief. The property is so small that it would be difficult to justify mobilizing a tool into the country during 1997 to survey only this property. However, there is little geologic support at this time for surveying the Flakstad property.

Budget: The estimated budget for the Flakstad project is:

	<u>\$Can</u>
Microprobe:	1,000
Sm-Nd determinations:	5,000
Helicopter for recon:	30,000
Geologists, 2:	15,000
Assays & report:	4,000
Travel & Misc.:	2,000
1996 claim fees:	<u>20,000</u>

Total:	\$Can	77,000	357,125,-
	\$US	59,000	

If an air-borne survey is to be done, this budget can be revised as necessary.

CONCLUSIONS: The southern Norway projects, Evje and Oгна, should be surveyed by airborne geophysical surveys in May, 1996. Follow-up ground work should commence immediately, and drilling should be anticipated on both projects during September-October, 1996. The Flakstad project needs additional ground work done before a decision about an airborne geophysical survey can be determined on geologic data alone. However, Flakstad could be flown while a tool is in-country for the south Norway projects.

Similarities of the crustal settings of the Norway properties with that at Voisey Bay indicates that major nickel-copper deposits could occur in feeder systems to these mafic complexes.

The overall budget recommended for the Norway properties in 1996 is:

	<u>\$Can</u>	<u>\$US</u>
Evje-Iveland:	592,000	455,000
Oгна-Egersund:	489,000	376,000
Flakstad:	77,000	59,000
General:	50,000	39,000
TOTAL:	1,208,000	929,000

The "General" fund is a minor contingency fund to provide the ability to pursue other opportunities should they become available, as well as cover any incidental expenses related to these projects.

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