PROJECT AND APPLIED GEOLOGY

GEOLOGY AND SELF–POTENTIAL SURVEY OF THE SYLVESTER K GOLD–SULPHIDE PROSPECT (82E/2E)

By B. N. Church

INTRODUCTION

This report gives the results of geological and self-potential geophysical surveys completed on Sylvester K and adjacent Crown-granted claims centred 1.5 kilometres northwest of the Phoenix mine and 5 kilometres east of Greenwood. The area has experienced an accelerated program of gold exploration, initiated mainly by Kettle River Resources Ltd.

HISTORY

The Sylvester K claim was, until recently, without much mining exploration activity since the beginning of the century when it was first staked. Several hand-dug trenches and a few shallow shafts on pyrite stringers are the only remnants from the early years of prospecting.

For many years Sylvester K was included in the extensive holdings of the Phoenix Copper Division of The Granby Mining Company Limited. In 1980 control passed to Noranda Mines, Limited and recently Kettle River Resources Ltd. acquired an option interest in the property.

The only production from the immediate area was recorded in the period 1967 to 1971. A total of 249 tonnes of ore was shipped to the Trail smelter from the Marshall Crown-granted claim, owned by San Jacinto Explorations Ltd. These deliveries yielded 11.94 kilograms of gold, 14.56 kilograms of silver, 472 kilograms of copper, 2 142 kilograms of lead, and 380 kilograms of zinc.

GEOLOGICAL SETTING

The stratigraphic, lithologic, and structural interpretation of the area is based on numerous scattered outcrops and excavations. The main units are sedimentary rocks of the Triassic Brooklyn Formation, a microdiorite stock and associated dykes, and a number of Tertiary intrusions (Fig. 1). Steeply dipping beds, typical of the area, are the result of important folding and a complicated history of fault movement.

BEDDED ROCKS

The Brooklyn Formation underlies most of the map-area. This is divided into two principal members comprising mainly sharpstone conglomerate at the base and a limestone sequence above. An argillaceous transition zone separates these members.

The sharpstone member consists of immature polymictic conglomerate 450 to 600 metres thick. It is characterized by an abundance of purple and grey, pebble-sized, angular chert clasts intermixed with greenstone fragments and accessory jasper, diorite, and limestone. Chemical analysis of a sample of the conglomerate from Knob Hill near the Phoenix pit (analysis No. 1, accompanying table) closely resembles the sharpstone conglomerate from Deadman Hill east of the map-area (*see* Church, 1976, analysis No. 2, accompanying table). Conglomerate beds are intercalated with green sandstone and siltstone, several limestone lenses, and discontinuous argillite layers. The 'Rawhide shale' is a local, thick shale facies developed near the base of the sharpstone member southeast of the Phoenix mine (analysis No. 2, accompanying table).

CHEMICAL ANALYSES OF SOME TYPICAL ROCKS FROM THE SYLVESTER K AND PHOENIX AREA (83E/2E)

	1	2	3	4	5	6
Oxides Recalculated to 100–						
SiO_2	74.81	68.04	41.05	54.19	63.12	60.23
TiO_2	0.89	0.81	0.75	0.37	0.91	1.25
Al_2O_3	9.55	13.82	13.08	15.64	15.43	18.17
Fe_2O_3	0.83	0.43	6.74	1.12	2.38	0.56
FeO	4.91	6.81	8.59	6.42	2.73	4.29
MnO	0.06	0.06	0.32	0.13	0.08	0.09
MgO	3.69	4.30	4.49	8.49	3.30	1.59
CaO	2.40	1.07	24.41	10.39	4.67	1.95
Na_2O	1.71	1.37	0.04	2.61	3.33	4.92
K_2O	1.15	3.29	0.53	0.64	4.05	6.95
	100.00	100.00	100.00	100.00	100.00	100.00
Oxides as Determined–						
H_2O+	2.74	2.39	3.82	2.41	1.78	1.86
H_2O-	0.16	0.20	0.25	0.11	0.29	0.54
CO_2	0.89	1.60	1.21	<0.10	1.80	0.55
S	0.07	0.29	1.59	0.16	0.01	0.01
P_2O_5	0.25	0.21	0.20	0.20	0.28	0.21
Molecular Norms–						
Qz	43.9	31.2	3.7	3.7	13.6	0.0
Or	7.0	19.8	3.7	3.8	24.0	40.2
Ab	15.7	12.5	0.3	23.7	30.0	40.7
Ne	0.0	0.0	0.0	0.0	0.0	1.5
An	12.2	5.5	39.0	29.5	15.3	6.9
Wo	0.0	0.0	20.0	4.5	1.6	0.5
En	10.4	12.1	14.2	23.8	9.1	0.0
Fs	7.3	10.4	9.8	9.3	2.6	0.0
Fo	0.0	0.0	0.0	0.0	0.0	3.3
Fa	0.0	0.0	0.0	0.0	0.0	4.6
Il	1.3	1.2	1.2	0.5	1.3	1.7
Mt	0.9	0.5	8.1	1.2	2.5	0.6
Cr	1.3	6.8	0.0	0.0	0.0	0.0
	100.0	100.0	100.0	100.0	100.0	100.0

1 – Sharpstone conglomerate (Triassic), from upper north slope of Knob Hill.
2 – Rawhide shale (Triassic), 500 metres south of Snowshoe pit in rock cut on main haulage road.
3 – Skarn from southeast corner of Snowshoe pit.
4 – Microdiorite (Jurassic/Cretaceous ?), cutting Triassic beds 1.5 kilometres southeast of Phoenix pit.
5 – Pyroxene-feldspar porphyry (Tertiary), from Observatory Hill 700 metres north of Phoenix pit.
6 – Feldspar porphyry (Tertiary), 500 metres southeast of Phoenix pit.

The base of the sharpstone section in the map-area is apparently a low angle fault at a vertical depth of about 150 metres (*see* diamond-drill hole No. 20, Fig. 1). Here the contact of the conglomerate is marked by fault gouge and crushed grey chert of the basement complex. A similar relationship, obscured somewhat

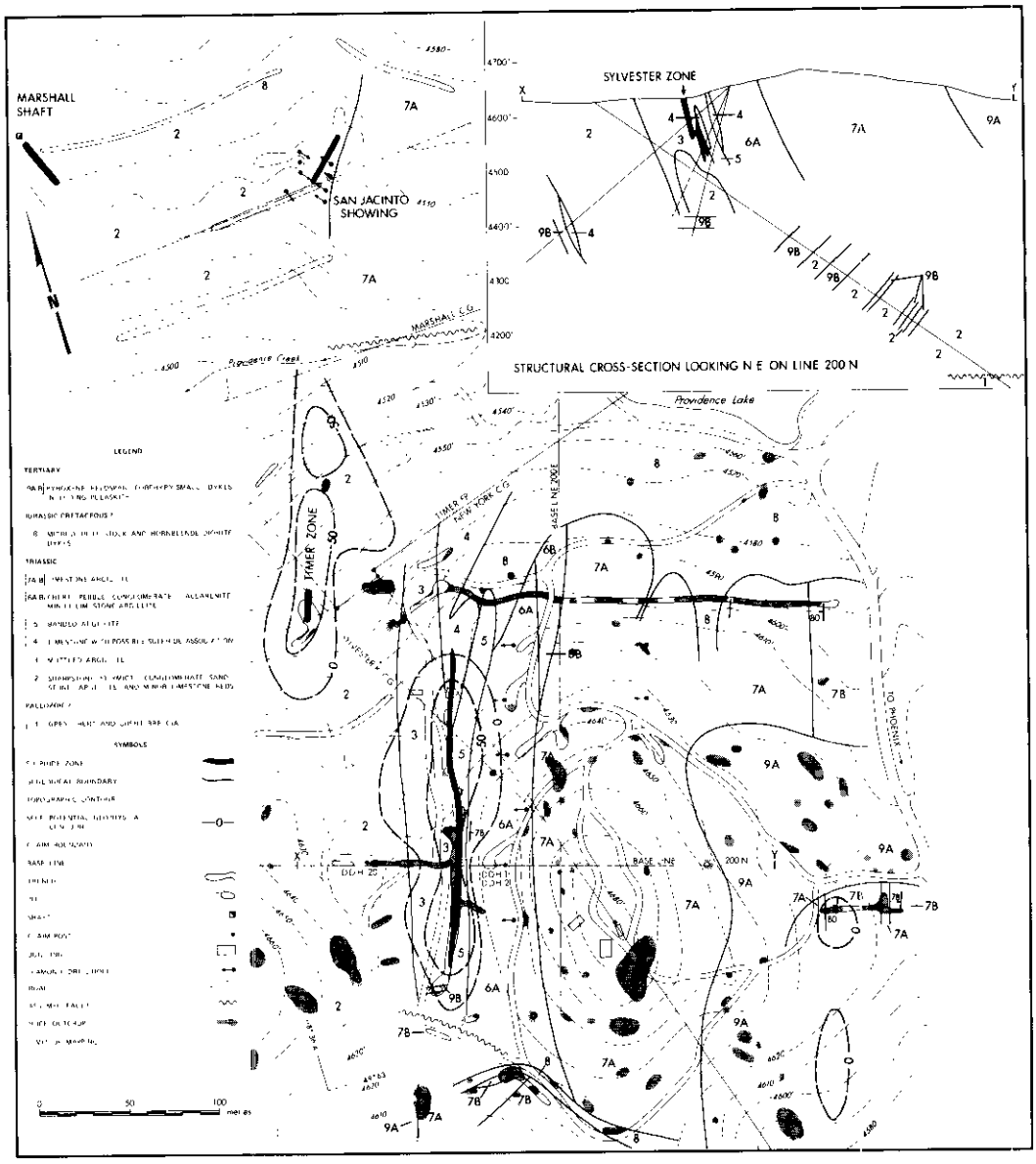

Figure 1. Geology and self-potential survey of the Sylvester 'K' gold-sulphide prospect (82E/2E).

The sharpstone member passes upward into a 60-metre-thick transitional zone of massive argillite with lenses of carbonate, layers of banded argillite and siltstone, and beds of mature sandstone and chert pebble conglomerate with carbonate bands. The argillite of this transition zone may correlate with the 'footwall argillite' of the Phoenix pit.

The Brooklyn limestone member is best exposed in the central and northern part of the map-area. It consists mainly of massive limestone, several hundred metres thick, with some intercalations of argillite such

as near the road to Providence Lake by the east boundary of the map-area. East of the map-area, stratigraphic relationships are unclear. There the Brooklyn limestone is apparently succeeded upward by another layer of sharpstone conglomerate, followed in turn by 'Stemwinder' limestone breccia. The Stemwinder is a peculiar, blocky breccia possibly related to a late volcanic episode cogenic with the Upper Triassic Eholt Formation seen near the Oro Denoro mine several kilometres to the east (Church, 1976, p. 4).

IGNEOUS INTRUSIONS

The main igneous intrusion is an irregular microdiorite stock several hundred metres in diameter exposed just south of Providence Lake. This is a greenish grey rock with a fine, even-grained texture. Thin-section studies show a predominance of rectangular, clay-altered plagioclase cyrstals, 0.5 to 1.5 millimetres in diameter, intermixed with a scattering of chloritized amphibole laths set in a matrix of altered feldspar, ferromagnesian minerals and a minor amount of quartz. Epidote is present in variable amounts, up to 10 per cent, occurring mostly in replacements of the ferromagnesian minerals and the calic cores of some plagioclase crystals.

Porphyritic grey dykes, found scattered widely throughout the map-area, appear to be offshoots of the Providence Lake microdiorite body. These rocks are fine grained with conspicious needle-like prisms of black amphibole 2 to 6 millimetres in length. In thin section, crowded, rectangular, and polygonally zoned plagioclase 0.5 to 1 millimetre across is mixed with subhedral amphibole prisms and glomerophenocrysts of magnetite and amphibole (~15 per cent) in a matrix of altered feldspar, chlorite, magnetite, and epidote.

Other significant microdiorite intrusions lie east of Providence Lake and near Hartford junction, 1.5 kilometres southeast of the Phoenix pit. Chemical analysis of a sample from the Hartford location is given in the accompanying table (No. 4). The age of the microdiorite is believed to be similar to the Greenwood batholith which has been dated by K/Ar methods at 125 to 140 Ma (Church, 1974, p. 49; 1976, p. 5).

Tertiary intrusions include a wide variety of pulaskite, pyroxene, and feldspar porphyry sills and dykes, many of which have been intersected in drilling. These rocks are generally fresh and show little sign of faulting or metamorphism. They follow fractures, are irregular in outline and dip, and commonly change orientation abruptly.

An irregular pyroxene-feldspar porphyry is the largest Tertiary intrusion. It cuts the Brooklyn Formation in the southeast part of the map-area. The rock is brownish with scattered cream-coloured polygonal feldspar phenocrysts and dark green augite subhedra. In thin section, augite (~5 per cent), zoned plagioclase crystals (15 per cent), and glomerophenocrysts, to 4 millimetres in diameter, are set in a matrix of interlocking alkali feldspar, plagioclase, and accessory biotite, quartz, magnetite, and apatite. Chemical analysis of a sample of this rock from the hill east of the map-area is given in the accompanying table (No. 5).

A Tertiary feldspar porphyry intrusion 0.5 kilometre southeast of the Phoenix pit is an alkaline, two-feldspar rock with no visible or normative quartz (*see* analysis No. 6, accompanying table). This dyke-like body intrudes a major gravity fault marking the contact between Early Tertiary sedimentary and volcanic rocks and skarnified sharpstone conglomerate.

STRUCTURAL GEOLOGY

The area in vicinity of the Phoenix pit and extending beyond Providence Lake and the Sylvester K prospect is an easterly tilted half-graben structure. Vertical displacements ranging to several hundred metres occur on some of the north/south and east/west bounding gravity faults. This structure, which is known to be of Early Tertiary age and has been extensively intruded by Tertiary dykes, is superimposed on folded and faulted rocks of the Brooklyn Formation.

According to Fyles (1982, Assessment Report 10 632, pp. 3-16) early deformation of the Brooklyn strata resulted in formation of an asymmetrical syncline with a vertical northerly trending westerly limb and a gently northwest-dipping easterly limb. The axis of this fold, which plunges 10 to 15 degrees to the north-northeast, passes east of the Sylvester K map-area to be intercepted by the Snowshoe fault north of Providence Lake. The Snowshoe fault is a major southeasterly trending low angle thrust or tear fracture displaced by the Tertiary graben structure.

Important faulting also occurs where the Brooklyn beds are exposed on the steep west limb of the syncline. For example, an east/west-trending left lateral strike slip fault on Providence Creek offsets the sharpstone and limestone contacts approximately 120 metres. Low angle faulting is also revealed by the drill results, where pre-Triassic basement rocks were intercepted at relatively shallow depth.

MINERALIZATION

Discovery of significant mineralization on the Sylvester K claim was announced by Kettle River Resources Ltd. on October 18, 1982. Backhoe trenching of a strong VLF electromagnetic anomaly revealed a zone of gold-bearing pyrite beneath 3.4 metres of soil and gossan.

Previously, the area seemed unpromising for exploration, except for pyrite in old pits where grab samples assayed as much as 0.26 ounce of gold. The only other encouraging evidence was a private report by W. H. White, dated September 1950, which outlined a copper/zinc biogeochemical anomaly close to the New York Crown-granted claim boundary near the present discovery.

Trenching has revealed a zone of massive sulphides exposed intermittently over a total length of 160 metres. The zone attains a thickness of more than 2.5 metres, dips steeply to the east, and strikes 015 degrees azimuth (*see* Fig. 1 and Plate I). The mineralization appears to be concordant with transitional strata between Brooklyn limestone and sharpstone conglomerate.

The following is a brief description of core from diamond-drill hole No. 6 which is midway on the zone:

THICKNESS IN METRES DRILL COLLAR	DESCRIPTION
>12.0	Grey sandstone and conglomerate with carbonate matrix — some rust on joints
0.6	Mottled massive argillite with orbicular structures
3.6	Light-coloured sandstone and some conglomerate with well-rounded chert pebbles
1.2	Hornblende porphyry diorite dyke
2.0	Chert pebble conglomerate with accessory clasts of varied composition
3.0	Chert sandstone and grit
2.3	Limestone with many sesame seed-like chert grains
3.0	Massive grey, silica-rich limestone
0.6	Hornblende porphyry diorite dyke
5.2	Banded argillite with a few pyrite bands
1.8	White hard limestone with mosaic pattern of small cracks
0.6	Mottled pyritic argillite
1.2	Calcarenite with thin greenish argillaceous band
3.0	Zone of massive sulphides (mostly pyrite) with some argillaceous impurities
9.4	Light brown to grey massive argillite with orbicular structures and many joints with thin *seams of pyrite*
>25.6	Hornblende porphyry diorite dyke with xenoliths of chert and epidotized argillite
75.1	metres total thickness of strata in diamond-drill hole No. 6

According to company reports, assay results on the 3-metre intersection of massive sulphide in drill hole No. 6 yielded 11.96 grams per tonne gold. At surface on baseline 200N, sampling across the sulphide zone yielded 5.6 metres assaying 9.12 grams per tonne gold, 7.54 grams per tonne silver, and 0.14 per cent copper. In the same area the footwall argillite assayed 1.99 grams per tonne gold and 3.77 grams per tonne silver across 18.0 metres.

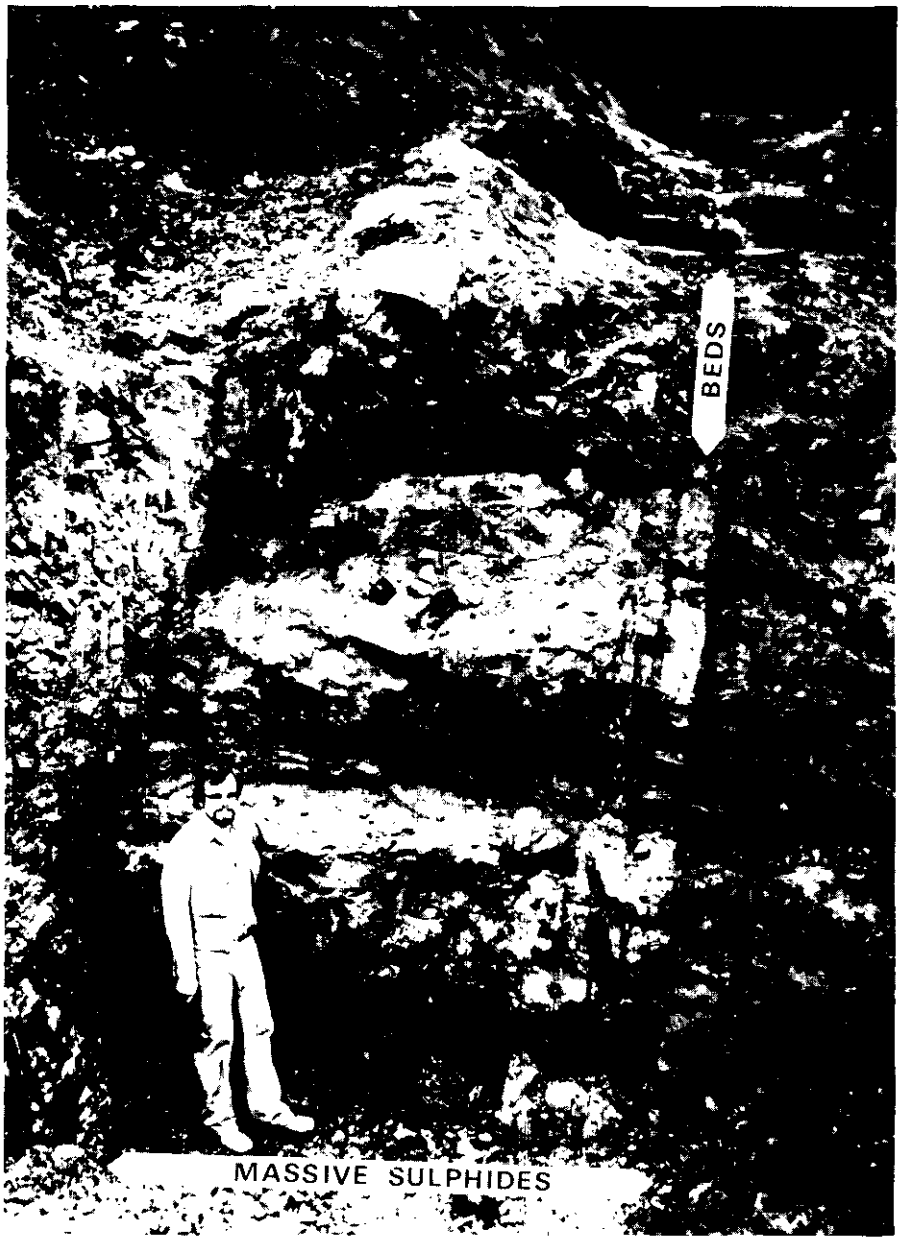

Plate I. Discovery trench on Sylvester K massive sulphide zone.

The mineralogy of the ore zone is simple. Pyrite, the principal sulphide, is accompanied by accessory pyrrhotite and marcasite, and trace amounts of chalcopyrite. In paragenetic sequence, pyrrhotite probably formed early from warm mineralizing solutions and marcasite developed later in a cooler environment.

Gangue minerals include carbonates, quartz, and chlorite. These are intermixed with sulphide grains or interbanded forming lenticular masses.

Secondary alteration by oxidation and groundwater action produced a limonite-goethite cap several metres thick above the ore zone. Trenching of this gossan has revealed peculiar Karst-like cave structures. Rapid oxidation of newly exposed pyrrhotite and marcasite in the trench produces a white powdery coating consisting of a mixture of rozenite and melanterite.

In a similar setting, the San Jacinto sulphide zone, 120 metres west of Providence Lake on the Marshall Crown-granted claim, contains an even wider range of minerals, which includes magnetite, specularite, galena, garnet, epidote, and amphibole.

The targets for mineralization are thin limestone beds in the transition zone, exemplified by the Sylvester K and San Jacinto prospects, and limestone lenses in the sharpstone unit which host the 'Timer' and Marshall shaft prospects. These are classified as calcic exoskarn deposits following the system of Einaudi and Burt (1982). Accordingly, it is theorized that the metasomatic fluids followed the course of the microdiorite dykes into the stratigraphic pile then infiltrated bedding planes. Recrystallization of the carbonate units by these warm fluids produced granular or sugary textures that facilitated further infiltration and eventual wholesale replacement.

The effect of the mineralizing solutions on wallrocks of the ore zone is well displayed on the Sylvester K claim. For example, the footwall argillite on line 200N, which is normally pale green, has been transformed into a light brown fine-grained biotite-bearing hornfels. Here numerous thin pyrite stringers carry gold and silver values for more than 10 metres outward from the massive sulphide zone. In other areas, chlorite and hematite are common on joints and cracks in the host rocks.

Diffusion metasomatism in the argillite is manifest by reaction of the host with carbonate clasts. In this process the clasts are transformed to orbicular or ameboid-shaped structures, 0.5 to 2 centimetres in diameter, with carbonate-epidote cores and tremolite-actinolite rims. The argillite consists of very fine-grained quartz, feldspar, biotite, and small amounts of pyrite and chlorite. In some orbicular structures pyrite has formed in the cores together with calcite and epidote.

The source of the mineralizing solutions is believed, by some Kettle River geologists, to be the microdiorite, although exposures of this rock are small and no significant mineralization is visible south of Providence Lake where it intrudes the Brooklyn limestone. However, considering the wide distribution of microdiorite in the area, including the broad distribution of related dykes, it is possible that the main parent plutonic body lies at depth.

A volcanogenic origin of the mineralization has been considered and dismissed by K. Dawson of the Geological Survey of Canada who visited the area with the writer. The principal lines of evidence arguing against this theory is calc-silicate assocation and textural features pointing to infiltration and replacement by ore solutions. No 'tuff' or 'vent rocks' have been identified with confidence by the writer in the immediate area.

SELF POTENTIAL SURVEY

A self-potential survey was completed covering the Sylvester K prospect and adjoining areas southwest of Providence Lake. Where the targets are conducting massive sulphide bodies such as the Sylvester K discovery or Phoenix-type deposits, the self-potential geophysical method is known to be a particularly useful exploration tool in delineating buried mineralization.

The survey was performed utilizing an existing cut and chained line grid (50-foot intervals) employing standard procedures, such as fixed electrode configuration including constant connecting wire length, electrode zeroing at base stations, and a base reference station (at grid point 200N, 200E).

The results from 324 stations surveyed show a range of values, mostly between −8 and +39 on the millivolt scale. The lowest readings obtained all coincided with sulphide mineralization:

PROSPECT	READING
Sylvester K	−329
San Jacinto	−215
Timer	−194
Marshall shaft	−262

To illustrate the main results, isopotential contours at 0 and −50 millivolt levels were drawn from the grid and superimposed on the geological map (Fig. 1).

The survey shows two northerly trending anomalies which coincide with Sylvester K prospect, in the central part of the map-area, and the Timer zone about 100 metres to the northwest. The Timer anomaly is especially interesting because it suggests buried mineralization extending over a length of about 150 metres, approximately the same size as the Sylvester K prospect. According to company reports, sampling of sulphides from a trench near the south end of the Timer zone yielded assay results ranging to 5.1 grams per tonne gold across a 3-metre width.

On the north, the Timer anomaly points beyond the survey grid area toward the San Jacinto deposit. A connection here would almost double the estimated length of the inferred mineralized zone, however, this projection would transgress local stratigraphy and the Providence Creek fault lineament. Alternatively, the Timer zone might be displaced by faulting about 120 metres to the west, which would result in general alignment with the Marshall shaft prospect. In either case, the self-potential results show that the area holds additional opportunities for exploration.

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