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MANGANESE DEPOSITS

COWICHAN LAKE

VANCOUVER ISLAND

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Several manganese deposits are known in the Cowichan valley area on Vancouver Island. A map (Fig. 1) at the scale of two inches to one mile, accompanying this report, shows the area and its position relative to the principal points in south-western British Columbia. The Hill 60 deposit was discovered in 1918, and from it, in 1919 and 1920, manganese ore reported to total 1,117 tons was shipped to the Bilrowe Alloys Company at Tacoma, Washington. At the time when the work was being done on the Hill 60 property there was also some interest in the Black Prince Group on Shaws Creek and the Cottonwood group on Cottonwood Creek. The Shaws Creek deposit is now staked as the Manganese group and some surface work was done there in the 1939 season. It is also reported that some work was done by the owners on the Hill 60 property in the past two or three years. Other than these activities there seems to have been very little interest in manganese occurrences in the area for almost twenty years. References to the earlier activity will be found in the following publications:- Annual Report, Department of Mines, British Columbia: 1918, pages 296-298; 1919, pages 237, 238; 1920, page 24: Munitions Resources Commission, Canada, Final Report, pages 90-95: "Manganese Deposits of Canada", Geological Survey, Economic Geology Series No. 12, pages 115-119.

Because war-time conditions might make it very desirable to secure a source of manganese ore in Canada the writer was instructed to investigate the deposits in the Cowichan Lake area and to search for further deposits. This work was carried out from September 28th to November 4th, 1939. The crew assigned consisted of ten young men who had received training at the Dominion-Provincial Mining Training Project at Cowichan Lake from June to early September. The young men were willing and able, and cheerfully carried out the work assigned. A camp, situated at the Forest Experimental Station, on the south side of Cowichan Lake, was used for a base, and was occupied by the 10 trainees and the cook on September 28th. In the course of the work parties occupied camps at four different points. The usual wet fall climate of this area, with snow toward the end of the period, hampered the work somewhat.

The first work undertaken was at the Hill 60 property where the old cuts were cleaned out and some were enlarged. Trenching and stripping were also done looking for extensions of the deposit. While this work was in progress an effort was made to outline the favourable rocks nearby and farther west, and a more intensive search was made for manganese in what were regarded as the more favourable sections. Efforts to find bog manganese on the slopes below the known lode deposits were unsuccessful. Manganese oxide and silicate were found in place about 4,000 feet west of the principal Hill 60 workings and still farther west a discovery was made near Wilson Brook. Stripping and trenching were done to explore these

discoveries. Further work of the same nature was done on deposits which had been discovered on Meade Creek by one of the Mining Training Parties. The Cottonwood deposit which is on Widow Creek (a tributary of Cottonwood Creek) was also explored by stripping and trenching, and traverses for reconnaissance mapping were made as far west as a point between Mackay and Shaws Creeks. The writer visited the Shaws Creek deposit. The results of this work are incorporated in this report and the accompanying maps.

The manganese deposits occur in cherty tuffs, often closely associated with jasper. Manganese occurs as oxide, silicate, and carbonate, and as a hard, fine-grained mineral of light yellow colour, which has not yet been identified. The oxide, undoubtedly derived from the other minerals, is found in the weathered zone, forming a coating from a fraction of an inch to a few inches thick around cores containing the other minerals. The oxide also occurs filling small cracks which vein the unweathered rock, and as the principal residual material in completely weathered zones. The area has been glaciated and the weathered zones are generally shallow, accordingly the residual oxide rarely extends to a depth of 2 or 3 feet.

The ore shipped from the Hill 60 property came principally from the big pit from which practically all the oxide was mined. Black rock at points on the sides, and lying broken in the pit, is material, containing rhodonite and the yellow mineral, on which a thin coating of oxide has formed. It seems probable that closely spaced, steeply dipping joints to be seen in the walls of the pit, have favoured oxidation to a depth greater than is indicated at

other known deposits in the area. The maximum vertical range in the pit is about 35 feet but as the slope of the natural surface was steep, the bottom of the pit probably averaged 10 to 15 feet from the surface. An adit, crosscuts below the western end of the pit and about 10 feet below the deepest point, reveals surprisingly little oxide even in the cracks.

Study of the various deposits made it apparent that if an appreciable tonnage of manganese ore in bodies of workable size was found in the area, it would most probably be of manganese silicate, with some possibility of carbonate deposits, whereas oxide ore would probably be limited to small superficial occurrences. The following assays, presumably representing the range of material which was exposed at the surface (and therefore largely oxide) on the Hill 60 and Shaws Creek properties, are copied from the Munitions Resources Commission Report, pages 93 and 95:

Property	Sample No.	Metallic Manganese Per Cent.	Silica Per Cent.
Black Prince (Shaws Creek)	1	22.9	57.24
	5	40.8	50.18
	Lot 1 Test Shipment	22.09	58.16
Hill 60	1	15.88	62.84
	2	23.15	49.60
	3	57.15	10.04
	B	32.90	41.60
	R	46.50	18.90
	U	34.68	32.0

The following assays are from samples taken by the writer. The oxide was eliminated as far as possible in the field, by selection and cobbing. It was not possible to eliminate all the oxide, but the assays should give an indication of the probable manganese content of primary mineralization.

No.	Description	Manganese Per Cent.
6007-C	Jasper from Hill 60	7.0
6018-C	Black, fine-grained rock, containing some pink silicate and some brown carbonate replacing host rock along fractures - from Cottonwood deposit	13.8
6015-C	Silicified rock containing pink silicate and a little of the yellow material - Cottonwood deposit	21.2
6014-C	Banded yellow mineral, pink silicate and unreplaced host rock - west of Hill 60	21.9
6013-C	Selected yellow mineral with unreplaced cherty host rock - west of Hill 60	16.7
6005-C	Selected pink silicate with some quartz - Hill 60-A	29.9
6016-C)	Brown carbonate replacing dark grey brown rock - Cottonwood deposit	41.0
6017-C)		42.5

Cowichan Lake, about 18 miles long, occupies the upper end of a valley which was widened and deepened by glaciation. The lake is drained to the east by Cowichan River into Cowichan Bay. In the area in which manganese deposits are known to occur, the valley has a width of $1\frac{1}{2}$ to about 3 miles. The lake surface is

about 550 feet above sea-level, and the north wall of the valley rises steeply to elevations between 2,000 and 3,000 feet. The parallel Chemainus River Valley, farther north, forms the other boundary of a ridge which has a very uniform summit at the eastern end and rises at the western end to more rugged summits at elevations from 4,000 to 4,500 feet. Steep tributary valleys cut into the southern side of the ridge, particularly at the eastern end of the area, and in the western half Shaws Creek, Mackay Creek, and Cottonwood Creek, occupy wider valleys of low gradient.

The depth of overburden varies greatly, ranging from deep accumulations of drift at the sides of the valley and the outlets of branch creeks to a very thin cover on the steep slopes and on spurs of the main ridge. Much of the area was heavily forested, but at the eastern end and at Cottonwood Creek the timber has been largely logged and burned off. Logging is in progress on Shaws and Mackay Creeks.

The public highway runs along the north side of the valley from the Island Highway, two miles north of Duncan, to the village of Lake Cowichan, at the foot of the lake, a distance of about 17 miles, and continues along the north side of the lake to Youbou, about 9 miles from Lake Cowichan. The Esquimalt and Nanaimo and the Canadian National Railways have branch lines running up the valley to Lake Cowichan and the Canadian National line continues along the north side to the head of the lake. A logging railway extends up Shaws Creek for some miles, and is

being continued northward as logging progresses. A logging railway is also being built up Mackay Creek. The railway lines are devoted almost entirely to handling freight, principally logs and timber. Busses and trucks serve the communities along the highway and there is daily boat service for passengers on the lake. Logging roads furnish access to parts of the area and there are fair trails up Mackay and Cottonwood Creeks, and a rather poor trail up Meade Creek. Dense second-growth timber and debris in some of the logged or burned areas make travelling difficult.

The area lies within the Esquimalt and Nanaimo Railway Land Grant. Rights in the base metals were transferred to the railway company with the surface rights and accordingly the owners of surface rights may claim a royalty on base metal produced on claims within this area.

The area referred to in this report is included in various maps published by the British Columbia Department of Lands. The map in two sheets, at two inches to one mile, with topography indicated by 500-foot contours, accompanying this report, is reproduced from parts of three sheets of the Forest Branch (Department of Lands) maps covering the Esquimalt and Nanaimo Railway Land Grant. Memoir No. 13 of the Geological Survey, Canada, published in 1912, is accompanied by a map at six miles to one inch, on which the general geology of the area is indicated. The Duncan Sheet, at one inch to two miles, which

accompanies Memoir No. 96, published in 1917, covers the eastern end of the area, indicating the geology on a topographic base with 100-foot contours.

In the course of the Mining Training Project in the summer of 1939, the geology of various parts of the area surrounding Cowichan Lake was mapped under the direction of Professor Gordon Davis, using the Forest Branch map as the base. This mapping did not separate the tuffaceous sediments from the volcanic rocks of the Vancouver group.

Davis' geological mapping in the area referred to in this report, is reproduced on the two-sheet map mentioned previously. Some extensions to the sections mapped have been incorporated and where possible the tuffaceous sediments (Sicker series) have been outlined, based on mapping done from September 28th to November 4th, 1939, under the direction of the writer. Most of the traverses on which this added information is based were made by the young men who had received their training during the summer. The geological mapping is of a reconnaissance nature and in much of the area the various members of the Vancouver group are not differentiated. No effort was made to separate the volcanics of the Sicker series from the Vancouver volcanics and only in some parts of the area are Sicker series sediments differentiated from the Vancouver and the Sicker volcanics. The topographical base map, with 500-foot contours, is inadequate for the requirements of satisfactory mapping.

Manganese-bearing float has been reported from points south of the Cowichan valley and the writer was told of an occurrence near Skutz falls, thought to be in place, but not of commercial interest. All the known occurrences on which work has been done are north of the valley in tuffaceous sediments, apparently Clapp's Sicker sediments, which Clapp and Cooke place as probably younger than the Vancouver volcanic group and of Jurassic age. (Geological Survey, Canada, Memoirs 13 and 96.) The contacts of the Sicker sediments with the volcanic rocks are usually drift-covered. The rocks have been folded and faulted, the axes of folding and faulting being principally parallel with the trend of Cowichan valley, or from 55 degrees to 65 degrees west of north. Intrusive rocks, Saanich granodiorite, cut across the strike of the Sicker series. These conditions make it difficult to determine whether or not the manganese deposits are restricted to a limited stratigraphic range in the Sicker sediments. The Sicker series was recognized by Clapp from Moresby Island, on the east coast of Vancouver Island to about the west end of Cowichan Lake, and north as far as Nanoose Bay, interrupted of course, by other rocks.

In Memoir 96 (page 52) Clapp says that the Sicker sediments are at least from 2,000 to 3,000 feet thick, and the underlying volcanics of the same series have a maximum thickness of about 3,700 feet. In the more detailed description of the Sicker sediments in the same Memoir (page 136) C.H. Cooke mentions jasper lying directly on the amygdaloidal surface of a flow

(Sicker volcanic) in the canyon west of Coronation Mountain and states (page 142) that the jasper is simply a ferruginous chert. Cooke places the jasper and cherty tuffs among the lower members of the Sicker sediments, being succeeded by softer tuffs which are in turn succeeded by slates that in some localities have been rendered schistose.

Most of the known manganese occurrences in the area are close to or in contact with jasper. At various points beds or lenses of jasper and ferruginous slate, from half an inch to 2 or 3 inches thick, are interbedded with grey cherty tuff but where the jasper is well exposed it is not traceable continuously for any great distance. At the Hill 60 deposit where the most extensive exposures were found, bodies of jasper are from a foot or two to twenty feet in thickness, but they are irregular in outline and appear to be masses of comparatively short length. This is probably because they are in faulted ground; otherwise it would appear that they must have been formed by the alteration of some other rock, possibly by replacing masses of limestone. The writer did not see any limestone in the Sicker sediments and Cooke mentions only one occurrence of limestone, a thin bed in the softer cherty tuffs, but he does say that most of the soft cherty tuffs contain calcium carbonate. Cooke, however, says definitely that the cherty tuffs and jasper were laid down as such and were not formed by silicification of softer rocks.

There is evidence of the introduction of quartz at most of the manganese occurrences where host rocks are cut by numerous narrow quartz-filled fractures. Some sulphide mineralization is also to be observed. The contrast developed on weathered surfaces, frequently brings out the fact that manganese occurs in small lenses parallel with the bedding of the enclosing cherty tuffs and jasper. Individual lenses are usually less than two inches thick but may be so closely spaced that they constitute 50 per cent. or more of the rock, for widths from a few inches to several feet. Freshly broken, unweathered material, also indicates masses of pink siliceous material consisting of rhodonite and presumably of fine-grained quartz. Some of the masses are as wide as two or three feet. The pink silicate is also seen veining the rock and replacing it along the sides of fractures, a similar relationship was also observed for buff-coloured carbonate at the Cottonwood deposit. This buff-coloured mineral apparently consists largely of manganese carbonate and is seen replacing fine-grained, black, cherty rock. At most of the deposits there is a fine-grained siliceous material of a light yellow colour (Bementite ?). It is frequently intimately associated with the pink silicate and the two with fine-grained colourless silica form a banded rock, the banding is assumed to be parallel with the bedding of the wall-rock. The deposits consist of interleaved lenses or lamellae of short length, rather than continuous layers of any one mineral. The pink silicate is observed to vein and probably to replace the yellow silicate. The yellow silicate

in turn is seen to have replaced the jasper. Several thick bodies containing considerable amounts of manganese-bearing minerals, and otherwise markedly differing from the host-rock, appear to pass by transition, along the strike, into the more normal country-rock; at least there is no structural break exposed. The manganese-bearing bodies appear to be irregular, rudely lenticular masses, having the long dimensions approximately parallel with the bedding of the enclosing rocks.

The known occurrences are short in relation to their thickness. Little is known about the depth except from the workings at the Hill 60 property and the exposure in the canyon. However, as the manganese mineralization appears to be generally parallel with the bedding and, as in the eastern half of the area the bedding planes stand steeply, it seems reasonable to assume that the dimension down the dip of the beds will be comparable with that along the strike. This assumption is confirmed to a degree by the workings on the Hill 60 property and the canyon.

The apparent bedded nature of the deposits and the abundance of quartz veinlets probably supply the local evidence in support of one theory of deposition, namely, that the primary manganese is of sedimentary origin and has been converted to rhodonite by silicification. In Memoir 13 Clapp suggested that the cherty tuffs had been silicified but in Memoir 96 Cooke states that they were laid down as such, and were not the result of regional silicification, his argument appears to have been accepted by Clapp. The theory that the manganese silicates were

developed by the silicification of manganese minerals deposited during sedimentation, does not appear to be in accordance with the following observations.

(a) The manganese-bearing bodies are irregular in outline, and generally widely spaced and, although their longer axes are approximately parallel with the bedding planes, the bodies are short relative to their thickness.

(b) Some of the lenses are 1 foot to 2½ feet thick consisting largely of manganese silicate without observable bedding.

The development of such bodies does not seem to be explained reasonably by sedimentation.

(c) Megascopic examination indicates that the manganese silicates and carbonate vein and replace earlier rock minerals.

The manner of deposition and the relation of the deposits to the host-rock are not clearly indicated, though microscopic study may throw further light on the matter. These points are of considerable interest in determining future policy in regard to the deposits.

The primary mineralization, consisting of manganese silicate associated with quartz or crystalline silica, is probably of no present economic interest unless means of concentration can be developed. Carbonate ore of good grade appears to have a greater chance of proving useful economically. The discovery of carbonate ore running 40 per cent. manganese in

the Cottonwood deposit is therefore of some interest. This deposit is incompletely delineated on the surface but the carbonate is exposed across an apparent width of 6 or 8 feet and may extend for some distance along the strike.

The nature of the known occurrences in the eastern part of the area, with the inaccessibility of the Meade Creek occurrences, render that part of the area of less present interest than the territory from the Widow Creek fork of Cottonwood Creek westward to Shaws Creek. Parts of this section are much more ready of access and are already provided with means of transportation or could be provided more cheaply than could Meade Creek for example. The Shaws Creek and Cottonwood Creek deposits have larger areas of manganese-bearing rock exposed than are known at present at the other deposits and this fact also served to make this part of the area of greater current interest than the eastern section.

Probably there are substantial sections underlain by favourable rocks, lying between the Shaws Creek and Cottonwood Creek manganese deposits. This part of the area is more rugged than the eastern section, and owing to the lateness of the season could not be examined and prospected. There is a fair trail up the main fork of the Cottonwood. A trail runs up Mackay Creek and over the divide to Jump Creek, and a logging railway is being built up Mackay Creek. The logging railway on Shaws Creek will probably be within three-quarters of a mile from the manganese deposit in the near future. This part of the area is accordingly not difficult of access and could be prospected during the summer season.

The approximate positions of the known manganese occurrences are shown by index numbers in circles on the large-scale map accompanying this report. Plans at scales of 1 inch to 20 feet, and 1 inch to 50 feet, also accompany this report, and supply information concerning five of the occurrences. The following notes give salient points concerning the various deposits.

(1) Shaws Creek deposit, situated about 5½ miles north of Cowichan Lake. The workings consist of strippings and open-cuts (see plan) reached by a rough trail about two-thirds of a mile in length leading from an old cabin on the west side of Shaws Creek. The cuts are at approximately 1,900 feet elevation which is about 500 feet higher than the cabin. The cuts are understood to be in ground covered by the claims Manganese, and Manganese Nos. 1, 2, and 3, recorded in the names of A.W. Wylie, R.A. Wylie, and R.W. Wylie. The claims are within Block 110, Crown-granted timber land. It is reported that ownership of the timber land carries rights in respect of base metals, and that the owner could charge a royalty on base metals produced. The timber is being logged by Industrial Timber Mills Ltd. The logging company operates a railway which is being extended up Shaws Creek. At the middle of October the track had reached a point about 1¾ miles south of the cabin, grading extended farther north, and the end of slashing was about three quarters of a mile south of the cabin. The Shaws Creek deposit has been incompletely explored by trenching and stripping. Some of the

trenches from 1½ to 2½ feet deep have not exposed bed-rock. The bed-rock, consisting of jasper and cherty tuffs, has been folded and faulted. Some of the manganese-bearing rock lies almost horizontally and some dips west of north at angles up to 60 degrees. Samples taken by the writer ranged from 13.9 to 29.9 per cent. manganese. Oxide ore of somewhat higher grade could doubtless be selected.

(2) The principal Cottonwood Creek showing is west of Widow Creek (a tributary of Cottonwood) about 3 miles by trail from Cottonwood Creek and about 4¼ miles from the Canadian National Railway near the mouth of Cottonwood Creek. Up the latter creek and for about a mile up Widow Creek the trail follows an abandoned logging railway grade. The showings, about a quarter of a mile northwest from the main trail, and 500 feet higher than it, are at about 2,750 feet elevation.

Stripping and some trenching, (see plan), done under the writer's direction, exposed quartz, manganese silicate, and some carbonate replacing dark, fine-grained, cherty, rock. Samples of this material ranged from 13.8 to 21.2 per cent. manganese. At the north-east corner, a mass of brown carbonate rock is exposed with an indicated width of 6 feet or so. Samples of this material assayed 41.0 per cent. to 42.5 per cent. manganese. The deposit is incompletely exposed.

(3) On a branch creek about 200 yards east of Widow Creek, a band 1½ to 2 feet wide, containing a good deal of manganese silicate, is exposed at two points, about 100 feet apart. This occurrence is at approximately 2,175 feet elevation and has had no work done on it. The immediate wall-rock is jasper impregnated with pyrite.

(4) Meade Creek. Outcrops of manganese-bearing rock were discovered at three points east of Meade Creek during the summer mining training project, and stripping was done at two of the discoveries which are about 250 feet apart. Some further work was done in October. Widths here are usually less than 3 feet and often less than 2 feet; the manganese oxide gave way to silicate at shallow depth. These exposures are at elevations from 2,775 to 2,900 feet, and more than five miles by rough trail from the main road.

(5) The Wilson Brook discovery at approximately 3,100 feet elevation, is about two-thirds of a mile south-east of a trapper's cabin on Wilson Brook. There are two irregularly lenticular masses each from a few inches to a foot wide and about 20 feet long.

(6) About 4,000 feet west of the Hill 60 workings boulders of tuffaceous sediments partly replaced by pink manganese silicate and the yellow mineral were discovered on a bare spur, at approximately 1,700 feet elevation, half a mile north of the main road. Overburden is several feet deep. Down the slope from the boulders similar material was found in place up to 4½ feet in width. A source of the boulders up the slope was not discovered. The bed-rock is shattered where exposed and it appears that there has been some faulting. A sample containing a good deal of the yellow mineral and very little of the pink silicate assayed 16.7 per cent. manganese, and one estimated to contain about equal parts of the yellow mineral, pink manganese silicate, and unreplaced wall-rock, assayed 21.9 per cent. manganese.

(7) Hill 60-A. North-west, across the head of the canyon from the main Hill 60 workings, several old cuts expose manganese silicate mineralization, replacing cherty tuffs (see plan). The mineralized band is slightly offset where cut, by an andesite dyke, and by a fault, in one cut. The cuts, separated by moderate distances, do not show very good alighment and it may be assumed that the ground between them has been disturbed. The depth of overburden and the faulting prevented tracing the manganese-bearing rock farther. This occurrence is different in character from the main Hill 60 showing, and appears to be at a different horizon in the Sicker series.

(8) Hill 60-B. A large pit from which the Hill 60 ore was mined, a smaller pit nearby, and an adit which crosscuts under the western end of the big pit are the main workings at the Hill 60 property (see plan). A short adit has been driven in the canyon some distance to the west and there are shallow cuts and strippings both east and west of the main workings. These workings are understood to be on the Hill 60 claim. The Crown-granted claims Hill 60 and Hill 60 No. 2, which had reverted to the Crown, were acquired by W.R. Wylie of Vancouver in 1938. A branch road runs north-west from a point on the highway, a little less than seven miles east of Lake Cowichan. From the end of the branch road a trail may be followed about $1\frac{3}{4}$ miles to the workings. From the short adit on the side of the canyon there are strippings and trenches distributed through a distance of 1,200 feet to the east. The longer adit is at about 2,515 feet elevation and the top of the big pit, at about 2,760 feet elevation.

The steep escarpment, on the north side of a spur running west into the canyon, marks a fault which can be followed for about 200 feet east of the canyon where it is covered with overburden. The main fault strikes almost due east but some strands diverge east of south. It is thought that a strand may continue east past the principal workings in a shallow draw. The big pit is in or alongside a considerable mass of jasper, other masses of jasper are found to the west along the fault, the short adit in the canyon, is in such a mass. Practically all the ore shipped must have come from the big pit. All the oxide ore was apparently mined and it is reported that the oxide gave way to the pink silicate at a depth of about 15 feet. Some manganese silicate remains in the north-east and south-west corners of the big pit, but none was observed in the adit and surprisingly little oxide was seen there. It is possible that at the elevation of the adit more silicate would be found below the center of the big pit. Thin coatings of manganese oxide have formed on the broken rock in the pit and on the dumps. There are scattered occurrences of oxide in the shallow surface workings, the best showing being about 600 feet east from the big pit.

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Vancouver, B.C.
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