Geological Report.
Lode claims USS 1 - 7 incl.
Similkameen Mining District.
Lodestone Mt., 14 mi. west of Princeton, B.C
49° 121° SW. 49° 120° SW
John C. Ruckmick. 92H/7W
July 19 - Sept. 15, 1956.

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GEOLOGICAL EXAMINATION OF THE LODESTONE MOUNTAIN
ULTRAMAFIC INTRUSIVE AND ASSOCIATED MAGNETITE DEPOSITS

JOHN C. RUCKMICK

INTRODUCTION

The geological work described in this re ort was requested by James A. Noble in order to study in more detail the areal, structural, and petrological features of the Lodestone Mountain ultramafic body and its associated magnetite deposits. To the extent indicated by the accompanying affidavit, this report is submitted as the assessment work for the year September 20, 1955, to September 20, 1956, for the group of adjoining claims USS Lode nos. 1 - 7 inclusive, tag numbers 73235 through 73241, certificate number 81389 F, in accordance with the regulations provided in the Mineral Act of the Province of British Columbia.

The Lodestone Mountain ultramafic intrusive has been described in the following published reports:

Camsell, C., Geology and Mineral Deposits of the Tulameen District, B.C.; G. S. C. Memoir 26, 1913.

Young, G. A., and Uglow, W. L., The Iron Ores of Canada. B. C. and Yukon, G. S. C. Economic Series no. 3, 1926.

Rice, H. M. A., Geology and Mineral Deposits of the Princeton Map-Area, B. C., G. S. C. Memoir 243, 1947.

Portions of the ultramafic body along the Tulameen River and the vicinity of Lodestone Mountain were examined for Noble by R. H. Stebbins and D. M. Wilson in June and July, 1954. At that time a dip-needle survey was made of part of Lodestone Mountain and part of the ridge between Lodestone and Olivine Mountains.

GENERAL DESCRIPTION OF THE AREA

The map area extends from latitude 49°23' to 49°34' and from longitude 121°43' to 121°57'. The nearest town is Princeton, B. C. (population approx. 1200) which is 180 miles northeast of Vancouver over paved highway. Lodestone Peak, the approximate center of the map area, is 14 airline miles due west of Princeton. A well-blazed horse and foot trail leads from Lodestone Lake to a gravel road which leads to the small settlement of Coalmont. The trail is 2½ miles long, and the junction between the trail and the road is 9 miles from Coalmont or 21 miles from Princeton. The road is a gravel road which can be easily driven in a passenger car except where the road passes through the property of the Mullen Coal Mining Company at Blakeburn. There, strip mining operations required two-axle drive at the time of this work.

The southern portion of the map area is accessible by passenger car on a gravel logging road which proceeds from the Mullen Coal Mine along Arrastra Creek. To travel this road, permission is required from Norman Robb (telephone Princeton 150). The northern portion of the ultramafic body also can be reached in a passenger car on a gravel road which extends westward from Tulameen along the Tulameen River.

The Kettle Valley branch of the Canadian Pacific Railway passes through Princeton, Coalmont, and Tulameen.

The area underlain by the ultramafic intrusive consists of a high, dissected plateau along the eastern margin of the Cascade Range. Most of the high ground in the map area stands at an elevation between 5700 and 6200 feet above sea level. The maximum local relief on either the Princeton or Tulameen topographic sheets occurs where the Tulameen River cuts across the northern portion of the ultramafic. There, local relief exceeds 3000 feet and is quite steep.

The area is rather heavily forested in spruce except above elevations of 5500 feet, where there exist many alpine meadows and only a scattering of spruce.

In the summer the area is comfortably cool above 5000 feet and rather dry, since it lies within the rain shadow of the Coast and Cascade ranges. From November to mid-April, temperatures stay well below freezing, and snow accumulates at the higher elevations. Depths of 5 feet or more of snow commonly remain above 5500 feet until middle or late June.

OWNERSHIP OF LAND

Besides the group of USS Lode claims 1-7 on Lodestone Mountain, four other groups of lode claims in good standing and one area of crown grants cover portions of the ultramafic body. The locations of these claims and grants and the ownerships thereof are shown in the overlay accompanying the geologic map. Sixteen claims are owned by W. H. Tupper and J. W. Walsh, Attourneys-at-law, 675 Hastings Street, Vancouver, B. C., and 38 claims are owned by S. Donald Moore, 201 Wilkin Building, Edmonton, Alberta.

REGIONAL GEOLOGY OF THE LODESTONE MOUNTAIN ULTRAMAFIC INTRUSIVE

The regional geology of the ultramafic intrusive was mapped on a scale of 1 inch to 2 miles, using aerial photographs and the Princeton and Tulameen topographic sheets, 92 H/SE and 92 H/NE respectively, published by the British Columbia Department of Lands and Forests.

In horizontal section the main body of the ultramafic intrusion (exclusive of the gabbro intrusion) is an elongate pod, irregularly ovate, striking northwest and containing an outcrop area of approximately 20 square miles. An outlying satellitic body outcrops over an area of 1½ square miles at a distance 2 miles northeast of Lodestone Peak. Other outlying pyroxenite bodies have been mapped by Camsell on Skwum Creek, northeast of the map area, but were not investigated in the course of this work.

The trend of contacts across the regional topography indicates that the contacts between ultramafic and wall-rock are irregular but generally vertical or steeply dipping outward. The western and eastern contacts, measured in the bed of the Tulameen River, are vertical and dipping east at 55° respectively, but too much reliance cannot be placed on these local measurements because of the irregular nature of intrusive contacts. At the southeastern extremity of the ultramafic, the intrusion ends, and the accompanying gabbro intrusive dips outward at 40° to 50° and plunges to the southeast across Arrastra Creek.

For mapping purposes the ultramafic intrusive is here divided into three units defined as follows: pyroxenite - generally 70% or more monoclinic pyroxene (diopside); peridotite - 20% to 80% pyroxene (diopside), 80% to 20% forsteritic olivine; and dunite - 80% or more olivine (forsterite). Contacts between these three units are generally abruptly gradational over a distance of several hundred feet. In detail, however, contacts between dunite and peridotite are in some places of knife-edged abruptness. The pyroxene grades into the peridotite through the gradual acquisition of olivine and outward toward the periphery of the intrusive (especially toward gabbro) to hornblende pyroxenite and locally hornblendite with minor amounts of clinozoisite or epidote or both. Therefore, for more detailed mapping the ultramafic could be further divided into three additional units: hornblende pyroxenite; hornblendite; and olivine pyroxenite.

In the northwestern portion of the intrusive, the ultramafic units are concentric about the ellipsoidal dunite core and are arranged from the core outward: dunite; peridotite; pyroxenite. Pyroxenite, which composes the southeastern limb of the ultramafic, is everywhere peripheral to the other ultramafic units except along the northeastern margin of the intrusive, north of the Tulameen River, where a pyroxene-rich peridotite (80% diopside, 20% olivine) is in abrupt contact with gabbro. Here the gabbro can be interpreted as having cut out the pyroxenite, but more probably the peripheral pyroxenite is represented by the pyroxene-rich peridotite. As can be seen on the geologic map, the gabbro-pyroxene contact along the Tulameen River requires some interpretation. Although completely covered by a gravel bench along the north side of the river, this contact is abrupt and transgressive to the main structural trend of the ultramafic intrusive. In the pyroxenite along the river there are many obvious shear zones which intersect at approximately 45°, as indicated on the map. These features are sufficient evidence to assume an east-trending high angle fault along the pyroxene-gabbro contact, although the less likely possibility of a transgressive gabbro contact is not precluded.

The pyroxenite generally is a medium to coarse grained rock (grains 5 mm to 2 cm) which weathers to a gray-green color and is darker greenish-black in a freshly broken specimen. Magnetite weathers out of the rock in relief, having a metallic purple color. Where the pyroxenite contains olivine, the latter mineral weathers more rapidly and appears as yellow-brown depressions on the weathered surface. At the eastern contact in the bed of the Tulameen River the pyroxenite, here containing 30% hornblende in irregular clots up to 7 cm across, is noticeably finer grained within 400 feet of the contact with the Tulameen Group (grains 1 mm and less). Along the western contact in the Tulameen River and along the contact with the Tulameen metamorphics, 2 miles northwest of Lodestone Peak, the pyroxenite is highly foliated parallel to the contact and considerally serpentinized. A thousand feet into the intrusive from the western contact in the Tulameen River, a zone of pyroxenite breccia 200 feet wide crosses the river in the pyroxenite as shown on the geologic map. The breccia is composed of all sizes of angular pyroxenite fragments up to 3 feet in width cemented by a matrix of much finer grained pyroxenite. This feature is interpreted as a primary intrusive breccia formed during the intrusion of the pyroxenite.

Average peridotite is medium grained and composed of approximately 50% olivine and 50% pyroxene. The olivine is vitreous and clear on fresh sur_faces and weathers to a dun-yellow where not serpentinized. The pyroxene is probably a chrome diopside and is a brighter green than the diopside of average pyroxenite. Where not obliterated by serpentinization, the texture of the peridotite is composed of randomly mixed grains of pyroxene and olivine. Close inspection with a hand lens shows that the pyroxene in many specimens ophitically fills the interstices between olivine grains.

Most of the fresh dunite is composed of more than 95% of medium grained forsteritic olivine with only scattered grains of diopside. The olivine and pyroxene look essentially like those of the peridotite, and the unserpentinized rock weathers the typical dun color. In some places, notably on the northern slopes of Olivine Mountain, vertical bands or dikes of dunite from 6 inches to several feet in width cut the peridotite. Commonly along or near the dunite-peridotite contact, vertical bands of pyroxene-rich peridotite are found in the dunite.

A great deal, perhaps 70%, of both the dunite and the peridotite is considerably serpentinized, in which case the rock weathers a light gray-yellow with dark rusty streaks. Examination of serpentinized peridotite shows that the olivine is commonly selectively serpentinized and that the pyroxene is relatively fresh. Both the peridotite and the dunite show the serpentinized "breccia" structure (which Camsell has described) with blocks of fresh peridotite and dunite standing out in a serpentinized matrix. This is most frequently encountered along the Tulameen River and near the peak of Olivine Mountain. Large vertical serpentinized zones give the appearance of dikes in the dunite north of the Tulameen River.

The gabbro which accompanies the ultramafic is probably a separate intrusion; that is, neither is a differnetiate of the other, since there are essentially no intermediate rock types and no anorthosite exposed. Most of the gabbro is composed of approximately 50% black hornblende and 50% greenish clinozoisite or epidote. Within 100 feet of a contact with either ultramafic or wall-rock the gabbro usually shows a pronounced foliation of the hornblende parallel to the contact which gives the rock a schistose appearance. Some portions of the gabbro body east of Lodestone Peak are composed of greenish actinolized hornblende and flesh-pink manganiferous? clinozoisite. The central portions of this body and the gabbro north of the Tulameen River are composed of augite, hornblende, and plagioclase.

Although well exposed in several places, the contact between gabbro and ultramafic does not exhibit convincing age relationships. The hornblende content of the pyroxenite increases notably toward the gabbro contact to the extent that it could be locally mapped as hornblendite (more than 70% hornblende). Blocks of hornblendite ranging from several inches to 2 feet appear to be included in the gabbro and gabbro veins and dikes several feet wide cut the hornblendite. However, veins and dikes of similar size of hornblendite cut through the foliation of the gabbro. These confusing relationships are well exposed along the western margin of the ultrabasic two miles south of the peak of Olivine Mountain.

The confusing contact relationships between the gabbro and the ultramafic coupled with the space relationships argue toward simultaneity between the two intrusions. However, simultaneity at the molten stage would have caused mixing. Therefore, the most probable interpretation to account for the space relationships is that the ultramafic intruded the gabbro before the latter had crystallized completely; a relatively small interstitial fraction of the gabbro was either mobilized or kept liquid by the heat of the ultramafic intrusion until the ultramafic had crystallized.

The regular compositional sequence exhibited by the ultramafic intrusive is probably not a reflection of the differentiation of a single magma in the locale of intrusion for several reasons. No differentiation mechanism such as crystal accumulation could feasibly explain the petrologic structure of the body because there is no evidence of horizontal stratification, and all rock types are represented from pyroxenite, composed of 100% diopside, to dunite, composed of 100% olivine. If a process of crystal accumulation had controlled, some interstitial mineral or minerals representing the composition of the parent magma from which the crystals accumulated should be in evidence. Liquid diffusion is probably too slow to operate throughout a body of this size. Furthermore, the normal course of crystallization of an intrusive body should take place from the margins inward, in which case the highest temperature mineral (forsteritic olivine) should be found near the walls, with an increase of the lower temperature pyroxene inward. Since the reverse relationship is evident, any process of differentiation should explain crystallization of this body as having proceeded from the center outward. This phenomenon is not only mechanically unstable in a gravity field, but consideration of possible temperature gradients at the wall-rock contact makes it impossible to visualize the process without some crystallization from the walls inward.

Two possible explanations remain: either that the petrology represents an essentially dunitic magma peripherally contaminated with calcium and silica; or that it represents successive intrusion of a compound magma which, over the time spanning the intrusion, changed in composition from the lower temperature diopside melt to the higher temperature dunitic magma as a direct result of differential melting of the magma source, presumably in an inhomogeneous peridotitic layer in the mantle of the earth.

The latter explanation appears to be the more tenable hypothesis, since contamination of the olivine melt with calcium and silica but not other components such as potash and soda is difficult to imagine. The more plausible hypothesis of successive intrusion of a compound magma appears to explain both large-scale features, such as the central location of the dunite (since an arriving magma would find the easiest access to the more central partly liquid portion of the previous still crystallizing intrusive), and small-scale features such as dunite dikes intrusive into more pyroxene-rich peridotite.

Camsell's report contains good chemical and microscopic work on the ultramafic rocks, and the reader is referred to that work for more detailed petrographic descriptions.

The ultramafic, the gabbro, and the Eagle granodiorite are all clearly intrusive into the Triassic Tulameen sediments. The intrusives and the Triassic sediments are unconformably overlain by the Tertiary Cedar volcanics which appear on the eastern periphery of the map area. Camsell concluded from his work that the Eagle granodiorite is probably Jurassic and that the ultramafic and the gabbro are probably Jurassic but before the Eagle granodiorite. No evidence relevant to this dating was encountered in the course of this work.

MINERALIZATION

Both magnetite and chromite are clearly primary constituents of the ultramafic rock. The megascopic occurrence of chromite is is confined to a very few small irregular veins and clots in the dunite. These occurrences, generally only several inches in the longest dimension, are not frequently encountered in the dunite and will not be worth economic consideration in the foreseeable future.

Camsell's report mentions both diamonds and platinum with the chromite in the dunite, although their economic significance is doubtful.

Magnetite is essentially confined to the pyroxenite unit, although there is slight overlap into the peridotite south and northeast of the summit of Olivine Mountain. It occurs as disseminated clots and irregular veins of all sizes from 0.5 mm to several feet. In many places the grain size of the magnetite appears to vary in direct proportion to the grain size of the pyroxenite. This is probably because the disseminated clots are typically interstitial to the pyroxene grains.

The magnetite content of the pyroxenite is quite variable over large areas, as indicated on the geologic map. It is emphasized that the distribution of the magnetite percentages shown on the map is based solely upon visual estimate at the outcrop with the use of a hand magnet and not upon dip-needle values, which generally but not everywhere substantiate the observations.

There appears to be a general relationship between the percent of magnetite in the pyroxenite and the topography. The largest areas containing the highest percentage of magnetite lie along the ridge of Lodestone Mountain, on a 5600-foot southeast of Lodestone, and where the pyroxenite unit crosses the ridge south of Olivine Mountain. This feature indicates that magnetite must have been concentrated by primary processes at a higher level in the intrusion, relative to the average level now exposed. However, the valley between Lodestone Lake and the ridge extending south from the summit is worthy of more extensive investigation than was accomplished during the course of this work. One traverse in this area encountered very few outcrops of pyroxenite, all of which showed only traces of magnetite, and low dip-needle readings. It can be assumed that the topography and possibly the regional polarization of the Lodestone Mountain magnetite influenced the dip needle.

The Lodestone deposit has not been adequately sampled. In November of 1955, Karop collected a bulk sample for metallurgical testing, but because of snow cover this was perhaps not representative. Better than average ore was located by dip needle, and the resulting sample ran 20.5% total Fe, 19.6% soluble Fe, presumably better than average for the deposit as a whole.

Most of the ground covered by the seven USS Lode claims on Lodestone Mountain contains as high a content of magnetite as was observed anywhere on the ultramafic. However, the area of high magnetite content extends beyond these claims to the north and for a considerable distance to the southeast.

Of the claims located along the ridge extending southward from Olivine Mountain, owned by Tupper and Walsh, the northern, or Bear Group, covers ground which may contain as high a percentage of magnetite as the ground on Lodestone Mountain. The magnetite content of that portion of the ultramafic covered by the Deer Group, which adjoins the Bear Group, is sporadic and as high as 20% in only a few places.

All the ground covered by the block of 32 lode claims owned by S. D. Moore was not investigated. However, it is not probable that any of the ground covered by either of the two blocks of claims owned by Moore contains enough magnetite at the surface to be worthy of consideration at this time.

Some sulphides were observed, both disseminated and in small veins, on both sides of gabbro-ultramafic contacts, and in both the gabbro and ultramafic at wall-rock contacts. These are mostly pyrite with some chalcopyrite and pyrrhotite. No concentration observed appeared to be of any economic interest, although three samples collected near the western wall-rock contact of the ultramafic in the Tulameen River are being assayed.

OPERATIONAL FACTORS

The topographic features of the Lodestone Mountain magnetite occurrence favor open-pit mining, but the heavy snow fall might prevent year-around operation of an open pit. If the grade of the crude ore is high enough and the metallurgy presents no serious difficulties, it may be possible to place concentrates at tide-water near Vancouver in competition with ocean-borne ores. Water for a concentrator is inadequate except in the lower part of Granite Creek, in the vicinity of Blakeburn, or in the Tulameen River. Crude ore could be delivered to a concentrator on the Tulameen River by gravity tram, a method formerly used for the coal from Blakeburn.

RECOMMENDATIONS

Better figures on the average grade of the deposit are needed. Lines of samples should be cut across good ore exposures to test maximum and average grade and to establish correlations between grade and dip-needle values. Metallurgical tests should be made of representative bulk samples to determine the necessary fineness of grinding, the concentrating ratios, and the effect on TiO_2 content. An extensive program of diamond drilling will eventually be needed to determine tonnage and grade. These different steps should be taken in the order listed.

John C. Ruckmick
John C. Ruckmick,
Consultant

Ketchikan, Alaska,
September 15, 1956

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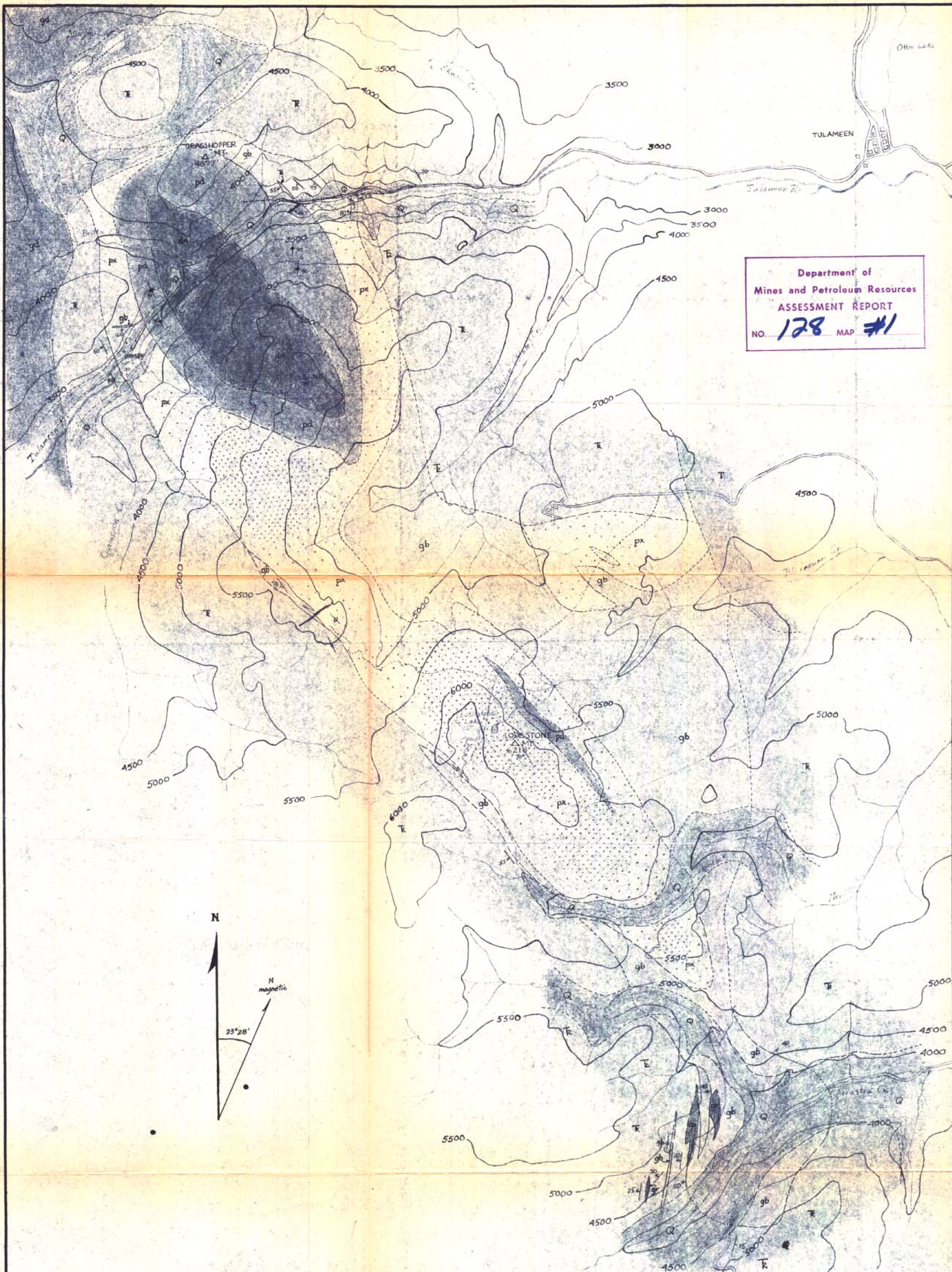
Qualifications of John C. Ruckmick:

Degrees:

Amherst, Mass., B.A. (Geology), 1952.
California Institute of Technology, M.S. (Geology), 1954.
Graduate residence toward Ph.D., California Institute Technology, 1952-56.

Experience:

Texas Company, field mapping, 1953.
Field work, ultramafics in Southeastern Alaska, for J. A. Noble, summers of 1954, 1955, 1956.



GEOLOGY OF THE LODESTONE MOUNTAIN ULTRAMAFIC INTRUSIVE,

YALE DISTRICT, BRITISH COLUMBIA

By
JOHN C. RUCKMICK

JULY, 1956

Scale = 1" = ½ mile 0 ¼ ½ 1 mile

Topography taken from TULAMEEN and PRINCETON sheets, NATIONAL TOPOGRAPHIC SERIES, CANADA SHEETS 92 H/NE & 92 H/SE.

LEGEND:

- Q — Quaternary gravels
- Diabase dike; TERTIARY (?)
- T — Cedar volcanic series; TERTIARY
- Ʀ — Tulameen group; TRIASSIC (?) l.s., volcanics, phyllites, etc.
- gd — Eagle granodiorite JURASSIC (?)
- gr — Pegmatitic granitic intrusives JURASSIC (?)

Basic & ultrabasic intrusive rocks:

- gb — gabbro { hornblende & plagioclase or hornblende & epidote, hornblende & clinozoisite
- px — pyroxenite { generally 90% + pyx. but locally varies to hornblende and/or magnetite rich types
- pd — peridotite (20-80% pyx, 20-80% oliv.) locally serpentinized
- du — dunite (80% or more olivine) locally serpentinized

Distribution of magnetite:

- 20% or more magnetite
- 10 to 20% magnetite
- px — traces to 10% magnetite

figures are visual estimates made with the use of a hand-magnet only.

Contacts:

- exposed
- approximately located
- inferred or taken from Camsell's report (G.S.C. Mem. 26, 1913)
- covered

- fault
- sedimentary bedding
- meta-sedimentary foliation
- igneous foliation
- igneous compositional banding

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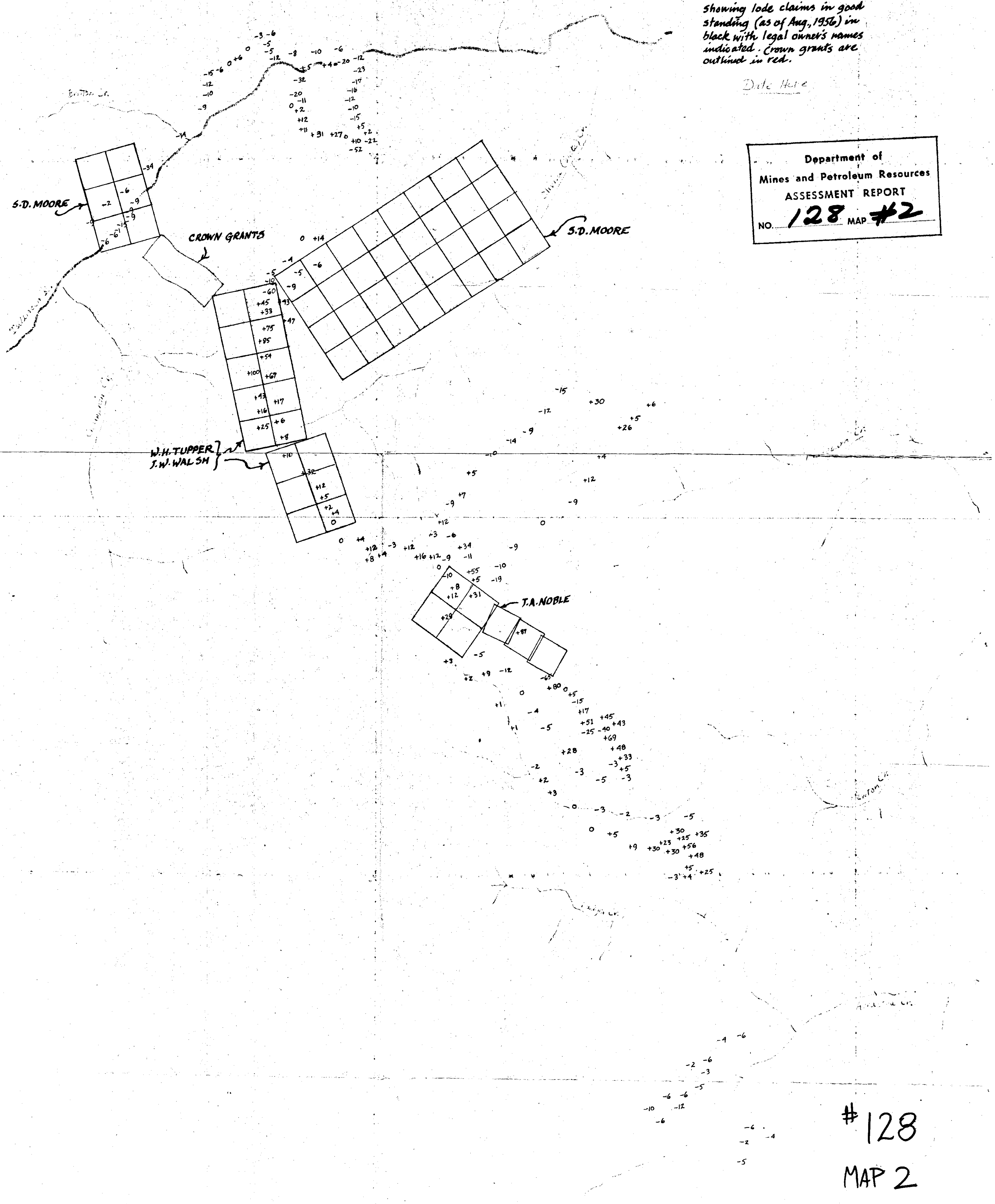
MAP 1

DIP NEEDLE SURVEY OF LODESTONE MTN. ULTRAMAFIC

Showing lode claims in good standing (as of Aug., 1956) in black with legal owner's names indicated. Crown grants are outlined in red.



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MAP 2