RESEARCH COUNCIL OF ALBERTA

Preliminary Report 62-8

GEOLOGY OF THE CHINCHAGA RIVER AND CLEAR HILLS (NORTH HALF) MAP-AREAS, ALBERTA

by

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Research Council of Alberta
Edmonton, Alberta
1962

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GEOLOGY OF THE CHINCHAGA RIVER AND CLEAR HILLS (NORTH HALF) MAP-AREAS, ALBERTA

Abstract

The Chinchaga River and Clear Hills (north half) map-areas comprise an area of 7500 square miles in the Plains region of northwestern Alberta. The area is part of a large dissected plateau composed of concordant, flat-topped hills surrounded by gently undulating lowlands. It is underlain by nearly flat-lying rocks of Late Cretaceous age covered by unconsolidated glacial and alluvial deposits of variable thickness.

The Cretaceous succession consists of alternating marine and nonmarine sandstones and shales with an aggregate thickness of 4000 feet. The rocks can be divided into six formation units correlative with the Shaftesbury, Dunvegan, Kaskapau, Bad Heart, Puskwaskau, and Wapiti Formations in adjacent areas.

Ferruginous, oolitic sandstones are locally present in the lower Kaskapau and Bad Heart units in the southern and eastern parts of the area. The thickest iron-rich deposits are of Bad Heart age and are present near Worsley and on Swift Creek in the Clear Hills. Thinner deposits of early Kaskapau age are locally present near the northern edge of the Chinchaga Hills.

INTRODUCTION

This report describes the general geology of the Clear Hills (north half) and Chinchaga River map-areas in northwestern Alberta. A reconnaissance survey of the region was carried out by helicopter during 1962 as part of a large program designed to map the bedrock geology of the northwestern part of the province.

The region is part of the northern Plains and is underlain by sandstones and shales of Late Cretaceous age mantled by unconsolidated glacial and alluvial deposits of variable thickness. The strata are nearly flat-lying and have been dissected to form a surface of moderate relief composed of concordant, flat-topped hills surrounded by gently rolling lowlands.

The discovery of oolitic iron deposits in the Clear Hills area has aroused considerable interest, and the report indicates the limits of areas that may be underlain by these or similar deposits.

The report is accompanied by a preliminary geological map of the region on a scale of 1 inch to 8 miles.

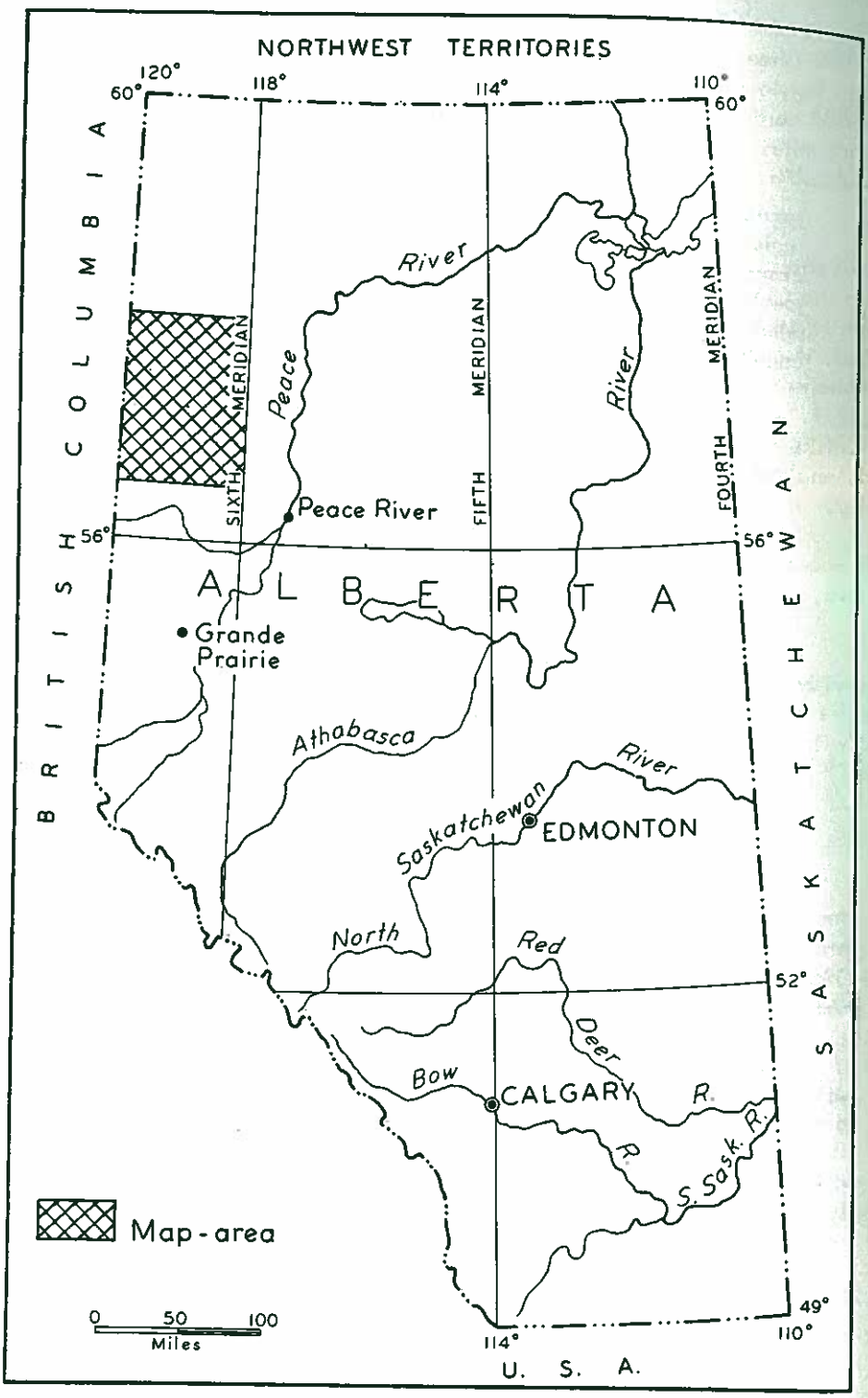

Figure 1. Location of Chinchaga River and Clear Hills (north half) map-areas.

Location and Access

The Chinchaga River (sheet 84E) and Clear Hills (sheet 84D, half) map-areas are located in northwestern Alberta between udes 118° and 120° west and latitudes 56° 30' and 58° north. her they form a rectangular area of about 7500 square miles, north e Peace River and adjacent to the Alberta-British Columbia dary (Fig. 1).

Most of the area is not readily accessible by vehicle. The ern part of the region, between the Peace River and the Clear Hills, ved by a gravelled highway which extends west from Hines Creek, ta, to Fort St. John, B.C. A second gravelled road, the Mac- ie Highway, lies from 10 to 20 miles to the east of the area, extend- orth from Grimshaw, Alberta, to Yellowknife, N.W.T. Narrow, veather roads connect the Doig, Clear Hills, and Notikewin forestry out towers with the Hines Creek-Fort St. John road, and the Chin- a and Keg River towers with the Mackenzie Highway.

Numerous seismic survey trails and oil well access roads are nt throughout the region but are generally impassable, except bly to tracked vehicles.

Various small lakes and forestry airstrips provide landing for fixed-wing aircraft, but helicopters constitute the most suitable e of access, a Bell 47 Super G helicopter equipped with skids being in the present instance. Much of the area is densely forested or ered by burnt-over forest, but small muskegs, river bars, and seismic s provide landing sites within reasonable distances of most outcrops.

Previous Work

The only published information dealing with the bedrock ogy of the region is contained in a report by Kidd (1959) describing ous iron-bearing deposits in the Peace River district of Alberta. report describes oolitic iron outcrops near Worsley and on Swift ek in the southern and eastern parts of the Clear Hills, respectively. lso contains a north-south cross section, based on well data, through Cretaceous formations underlying the eastern part of the region.

A brief summary of the glacial geology of the area is given Bayrock in a report of a reconnaissance soil survey of the area ndsay, Pawluk, and Odynsky, 1959).

Acknowledgments

L. G. Fahner and R. F. Toogood served capably as junior istants. Messrs. S. Adams and M. McArthur of Associated Heli- pters Limited, Edmonton, provided excellent co-operation throughout course of the survey.

Table 1. Succession of Strata in the Chinchaga River and Clear Hills Areas

Rock Unit			Thickness (feet)	Lithology
Wapiti Formation			0–400	soft, whitish sandstone; grey, blocky, carbonaceous shale; thin coal seams
Smoky River Group	Puskwaskau Formation		300–600	dark grey, fissile shale
	Bad Heart Sandstone		0–30	green, ferruginous, oolitic sandstone and mudstone
	Kaskapau Formation	upper member	150–410	dark grey, fissile shale
		lower member	40–155	whitish sandstone; grey, sandy shale; oolitic siderite
Dunvegan Formation			500–775	soft, grey sandstone with calc. concretions; grey, silty, carbonaceous shale
Shaftesbury Formation		upper member	300–550	grey, silty shale; thin, laminated siltstone
		lower member	600–1050	black, fissile shale; numerous fish scales

eet of beds in the upper part of the formation outcrop along the river, but ubsurface sections in the western part of the map-area are almost 1500 feet nick. The thickness decreases steadily eastwards to a minimum of 950 feet.

The Shaftesbury can be divided into two distinct lithologic nits or members. Beds adjacent to the contact between the two units are xposed along the Chinchaga River in townships 101 and 102, range 5, on ne Keg River in section 9, township 101, range 1, and along tributaries f the Hay River about 15 miles north of the map-area in township 107, nge 10. The contact can also be recognized in electric log profiles, here it is 100 to 190 feet above a thin, persistent sandy unit called the Fish-scale sand".

The lower member of the Shaftesbury Formation is 600 to 050 feet thick and is composed of soft, black, fissile shale, which pon weathering forms an abundant pale yellow or whitish powdery efflorescence on outcrop surfaces. Small, black fish scales are common, ut no other fossil remains were observed. The contact with the upper ember is sharp and is marked by a three-foot zone of extremely fissile, ack shales that break into thin sheets resembling tar paper.

The upper member is 300 to 550 feet thick, but the beds e less resistant than those of the lower member and only the lower 50 et of the unit were observed in outcrops. These beds consist of soft, ark grey, fissile to blocky shale containing scattered siltstone beds a w inches thick. The weathered shales have a reddish cast and typi- lly lack the yellow efflorescence of the underlying shales. Electric g data suggest that the unit becomes progressively more silty towards e top, where it is overlain conformably by the basal sandstone of the unvegan Formation. A westward and southwestward thinning of this nit on the western margin of the map-area is considered to indicate a teral passage into sandstone beds of the Dunvegan Formation.

Dunvegan Formation

The Dunvegan Formation forms a wedge of alternating ndstones and silty shales that is 500 to 775 feet thick within the map- ea. The rocks thicken to the west, where in northeastern British olumbia they form a sequence of coarse continental detritus that was posited as an arcuate wedge skirting the Cassiar - Omineca Mountains elck, 1955). In northwestern Alberta the rocks appear to have been posited near the margin of this wedge, under dominantly shoreline and goonal conditions of sedimentation.

The Dunvegan Formation underlies the lower slopes of the inchaga and Milligan highlands, and much of the lowlands adjacent the Chinchaga and Notikewin Rivers. The unit rises gently to the rtheast to form the caprock of part of the Naylor Hills. Exposures of e Dunvegan are rare throughout northwestern Alberta and are confined inly to small outcrops of the thick, unconsolidated sands at the base

and harder sandstones at the top of the formation. Examination of electric log profiles of subsurface sections suggests that the intervening sequence of strata is composed largely of thin-bedded silty shales and sandstones with scattered carbonate-cemented zones.

The basal sand is exposed several miles to the north of the map-area on a tributary of the Hay River in township 105, range 10, and also a few miles to the east of the map-area on the north flank of the Naylor Hills on Smeaton Creek in township 100, range 23. On Smeaton Creek it is composed of soft, medium- to coarse-grained, grey, crossbedded sandstone, with large calcareous concretions several feet in diameter, and has a sharp lower contact with the underlying silty shales of the Shaftesbury Formation.

A similar sandstone is exposed near the top of the formation on a small tributary of the Chinchaga River near the northern margin of the Clear Hills in township 97, range 6, where 25 feet of soft, grey, cross-bedded sandstone is in sharp contact with the overlying soft, black shales. Well indurated, crossbedded sandstones near the top of the formation also outcrop on the Notikewin (Sec. 4, Tp. 93, R. 4), Hotchkiss (Sec. 20, Tp. 95, R. 4), and Meikle (Sec. 24, Tp. 96, R. 4) Rivers.

Smoky River Group

The Smoky River Group comprises a thick, predominantly shaly sequence of marine strata that underlies a large area in the Peace River district of Alberta and British Columbia. To the southwest of the map-area, towards the Foothills, the succession can be divided into three shaly formational units, separated by two prominent, ridge-forming sandstones called the Cardium and Bad Heart Formations (Stott, 1961). In the eastern part of the Peace River Plains, the lower sandstone, the Cardium, is absent; thus, in exposures along the Smoky River to the southeast of the map-area the group can be divided into the Kaskapau Formation, Bad Heart Sandstone, and Puskwaskau Formation, in ascending order (Wall, 1960). This three-fold division of the Smoky River Group is generally applicable to equivalent rocks of the Clear and southern Chinchaga Hills but may not be applicable to the northwest part of the map-area where data are lacking.

Kaskapau Formation

The Kaskapau Formation comprises a sequence of soft, silty shales and fine-grained, ferruginous sandstones intercalated between the predominantly sandy beds of the Dunvegan Formation and the Bad Heart Sandstone. The formation underlies the slopes of the Clear and Chinchaga Hills in the southern and eastern parts of the map-area, but exposed sections are scarce and incomplete. It is also known to be present in the Milligan Hills to the northwest, although noted in only one outcrop in that area.

Subsurface data in the southern and eastern parts of the map-area indicate that the Kaskapau Formation is about 200 to 400 feet thick

there. It thickens rapidly to the south and west, attaining a maximum thickness of about 2200 feet in the Foothills west of Dawson Creek (Stott, 1961). In the Imperial Spirit River No. 1 well, 50 miles south of the map-area, the formation is about 1050 feet thick and contains several discrete lithogic units that can be correlated with similar beds in the Foothills on the basis of associated microfaunal zones (Stelck and Wall; 1954, 1955).

In the southern and eastern parts of the map-area the formation can be divided into two gross lithologic units based largely on interpretation of electric log profiles (Fig. 3). The lower member is predominantly sandy and appears to lie sharply but conformably on underlying sandstones of the Dunvegan Formation. The contact does not outcrop in the area but is exposed 40 miles to the south, on the Peace River at Dunvegan. The following succession of basal Kaskapau beds was measured at this locality:

Thickness (feet)	Top of section
(35)	(glacial deposits)
26	dark grey, silty shale, with thin ripple-marked siltstone and fine-grained sandstone beds increasing towards the top
7	thin bedded, orange weathering, fine-grained oolitic sandstone; sideritic, with worm burrows
4	thin bedded, orange weathering, argillaceous sandstone and dark grey, silty shale; numerous worm burrows
2	orange weathering, nodular, sideritic sandstone
4	finely laminated, silty sandstone and dark grey shale; numerous worm burrows
8	finely laminated, dark grey, silty shale
12.5	thin bedded, fine-grained, argillaceous sandstone; grades below into
1.5	dark grey, silty shale and siltstone
4.5	dark grey, fissile, silty shale
___	Base of the Kaskapau Formation
69.5	total thickness

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(35)	(glacial deposits)
26	dark grey, silty shale, with thin ripple-marked siltstone and fine-grained sandstone beds increasing towards the top
7	thin bedded, orange weathering, fine-grained oolitic sandstone; sideritic, with worm burrows
4	thin bedded, orange weathering, argillaceous sandstone and dark grey, silty shale; numerous worm burrows
2	orange weathering, nodular, sideritic sandstone
4	finely laminated, silty sandstone and dark grey shale; numerous worm burrows
8	finely laminated, dark grey, silty shale
12.5	thin bedded, fine-grained, argillaceous sandstone; grades below into
1.5	dark grey, silty shale and siltstone
4.5	dark grey, fissile, silty shale
____	Base of the Kaskapau Formation
69.5	total thickness

underlain by:
soft, argillaceous, grey, fine-grained sandstone with coaly partings (Dunvegan Formation)

The shales above and below the oolitic sandstone contain species of foraminifera characteristic of the Ammobaculites gravenori Zone of the basal Kaskapau shales below the Doe Creek Sandstone in the Imperial Spirit River No. 1 well to the south (J. H. Wall, pers. comm.).

Electric log profiles and sample cuttings from wells through the Kaskapau Formation in the Clear and Chinchaga Hills show the presence of a prominent sandy zone about 100 feet above the top of the Dunvegan Formation (Fig. 3). The zone is from 20 to 70 feet thick, locally thickening at the expense of the underlying shaly unit above the Dunvegan. In the Chinchaga Hills scattered ferruginous oolite fragments are present in sample cuttings from this sandy zone in a number of wells, the distribution of which is shown in figure 4 (in pocket). The thickness of this ferruginous bed (or beds) is not known, but the oolitic cuttings are not found in well samples to the south and southwest, where only sandstone is present (e.g. Shell Hotchkiss 10-29, Lsd. 10, Sec. 29, Tp. 93, R. 6).

Beds assumed to be equivalent to this zone outcrop on two small tributaries of the Chinchaga River in township 97, range 6. The succession of strata as measured on the western tributary in section 10 (approximate) is:

Thickness (feet)	Top of section
26	soft, fissile, dark grey shale; sharp lower contact
	Base of the upper Kaskapau member
0.5	soft, yellow, bentonitic(?) sandstone
0.7	hard, dark grey, sideritic sandstone
10	soft, orange weathering, fine-grained, white, quartzose sandstone; concretionary sideritic sandstone 4 feet from top; sharp lower contact
4	(covered)
9	soft, dark green-grey, silty shale; sharp lower contact
3	soft, orange weathering, argillaceous sandstone with numerous grey shale pebbles; grades below into

22	soft, grey, sandy shale, with scattered argillaceous sandstone lenses up to 6 inches thick
5	soft, orange weathering, fine-grained, argillaceous sandstone; concretionary siderite lenses at top; grades below into
20	soft, massive weathering, grey, sandy shale and argillaceous sandstone; numerous worm burrows
2	hard, dark grey, nodular siderite
2.7	soft, massive, argillaceous sandstone
1.3	hard, dark grey, nodular siderite
2.2	soft, massive, argillaceous sandstone, with thin siderite layer in middle
0.5	hard, dark grey, oolitic siderite, with small coaly fragments
2.5	soft, massive, argillaceous sandstone (to water level)
111.4	total thickness

Essentially the same sequence is exposed on another small tributary of the Chinchaga, about 3 miles to the east of the first. At this locality 6 feet of sideritic, oolitic sandstone and mudstone are present at the base of the section, about 70 feet below the top of the quartzose sandstone that marks the top of the lower Kaskapau member. Chemical analyses of three samples from this oolitic zone are given in table 2, along with a chemical analysis of the oolitic sandstone in the basal Kaskapau succession at Dunvegan (Section 1, Fig. 3).

Although no megafossils were found in either of the two outcrop sections, the age of the beds is confirmed by their microfaunal content, identified by J. H. Wall. Haplophragmoides spiritense is abundant in the dark grey shale above the quartzose sandstone that marks the top of the lower Kaskapau in the section described above, and Gaudryina irenensis is present in the sandy shales below the quartzose sandstone. H. spiritense is found above the Howard Creek Sandstone in the Imperial Spirit River No. 1 well, and G. irenensis is found beneath the Pouce Coupe Sandstone in the same well (Stelck and Wall, ibid.). Species characteristic of the Ammobaculites pacalis Zone, between the two sandstone members at Spirit River, are not present in the outcrop section, indicating the presence of an

Table 2. Chemical Analyses of Kaskapau and Bad Heart Oolitic Sandstones

Sample	1	2	3	4	A	B
SiO_2	12.14	24.92	12.30	27.52	28.43	36.21
TiO_2	0.20	0.15	0.16	0.21		0.25
Al_2O_3	8.47	18.42	11.04	6.30	6.77	5.53
Fe_2O_3	47.50	23.60	38.10	34.60	46.22	41.83
MnO	0.15	0.10	0.10	0.15		0.30
MgO	2.54	2.28	2.06	2.70	2.61	0.82
CaO	6.45	7.43	13.21	4.44		2.94
L.O.I.	19.09	21.68	21.11	21.66	14.12	10.43
P_2O_5	1.70	1.40	1.69	0.79		0.76
S	tr	tr	0.82	tr		0.01
Total	98.24	99.98	100.59	98.37	98.15	99.08
Fe	33.22	16.51	26.65	24.20	32.33	29.26

1. oolitic sandstone, basal Kaskapau, Dunvegan (Sec. 1, Fig. 3). S. Warchola, analyst.
2, 3, 4. oolitic sandstones, lower Kaskapau, Chinchaga Hills (Sec. 5, Fig. 3). S. Warchola, analyst.
A. oolitic sandstones, Bad Heart horizon, Swift Creek. Average of 15 core samples (Kidd, 1959, Append. II).
B. ferruginous sandstones, Bad Heart horizon, southern Clear Hills. Average of 5 outcrop samples (Kidd, 1959, Table V).

unconformity, probably at the top of the quartzose sandstone. This interpretation seems reasonable in view of the marked thinning of the total Kaskapau succession towards the northeastern margin of the map-area.

The upper member of the Kaskapau Formation consists largely of dark grey, fissile shale and silty shale between the sandy beds of the lower Kaskapau and the overlying Bad Heart Sandstone. The unit is from 150 to 400 feet thick in the subsurface and thins markedly to the northeast. Small exposures are present on the Doig River (Tp. 91, R. 10), in the Milligan Hills (Tp. 100, R. 12), and in the Chinchaga Hills as described above. The contact with the overlying Bad Heart Sandstone was not observed but appears to be gradational in wells and shallow boreholes drilled in the vicinity of Swift Creek, in the eastern part of the Clear Hills.

Bad Heart Sandstone

The Bad Heart Sandstone is a thin mappable unit in the middle part of the Smoky River Group and separates the Kaskapau and Puskwaskau Formations. In the type locality, about 40 miles south of the map-area on the Smoky River, the Bad Heart comprises 8 feet of fine-grained, argillaceous, quartzose sandstone capped by a persistent ironstone layer 1 to 2 feet thick

(Wall, 1960). The upper contact with the Puskwaskau Formation is sharp, but the lower contact is gradational into the silty shales of the Kaskapau Formation.

Within the southern and eastern portions of the map-area the Bad Heart is present as a ferruginous, oolitic sandstone that outcrops on the southern and eastern slopes of the Clear Hills north of Worsley and on Swift Creek (Kidd, 1959). Much shallow drilling has been carried out in these two areas to determine the grade and extent of the iron-rich deposits, which consist of lenses of oolitic, conglomeratic sandstone 10 to 20 feet thick, trending in a northerly direction (Fig. 4, in pocket).

North of Worsley the Bad Heart is exposed in a strip pit in the northeast quarter of Sec. 34, Tp. 87, R. 7, and in a bulldozed cut in Sec. 3, Tp. 88, R. 7, where it comprises the following composite sequence of strata:

Thickness (feet)	Top of Section
(5)	soft, dark grey, fissile shale; sandy in basal foot
(0.4)	hard, dark grey, nodular, oolitic sandstone (reworked?); sharp lower contact
	base of the Puskwaskau Formation
1.7	dark greenish-brown, densely oolitic sandstone, with clay partings and scattered shale and siderite pebbles
2	dark brown, densely oolitic sandstone, with greenish clay partings
0.7	conglomerate, composed of shale and siderite pebbles up to 1/2 inch diameter, with dark brown matrix
0.9	greenish-brown oolitic clay, with dark brown, oolitic sandstone stringers
0.7	conglomerate, composed of grey and greenish siderite and shale pebbles with dark brown matrix
6.0	massive, dark brown, densely oolitic sandstone, with large tree trunk impression about 4 feet from base; grades below into
4.5	orange-weathering,sandy claystone, with scattered ironstone nodules and pebbles up to 1 foot in

	diameter; sharp(?) lower contact underlain by 3 feet of soft, pale grey, bentonitic clay (Kaskapau Formation)
16.5	total thickness

Shales overlying the ferruginous sandstone at this locality contain a Puskwaskau foraminiferal assemblage, (J. H. Wall, pers. comm.). Also, Inoceramus pontoni and Inoceramus coulthardi, present in the Bad Heart Sandstone at the type locality (McLearn, 1926), were collected from the base of the sandstone (C. R. Stelck, pers. comm.).

To the north, on Swift Creek, the Bad Heart is about 30 feet thick but thins to zero feet a few miles to the west (Fig. 4, in pocket). The following section is present in a shallow borehole drilled in Lsd. 9, Sec. 2, Tp. 91, R. 5, about one-quarter mile west of the outcrops on Swift Creek (Mellon, 1962):

Thickness (feet)	Top of section
(75)	(glacial deposits)
0.3	hard, sandy mudstone
15	dark brown, densely oolitic sandstone; averages 37 to 39 per cent Fe
17	dark brown to green, moderately oolitic sandstone, with scattered blue and green shale pebbles and matrix increasing towards the base; averages 25 to 34 per cent Fe
10	dark bluish grey, pyritic shale
42.3	total thickness

Kidd (ibid.) noted the presence of scattered exposures of ferruginous sandstone along the southeastern margin of the Clear Hills which appear to be correlative with the oolitic phases of the Bad Heart to the north and west. Also, sample cuttings from a number of wells in the Clear Hills contain varying amounts of oolitic detritus, indicating that this oolitic facies of the Bad Heart Sandstone is relatively widespread (Fig. 4, in pocket). In most of the wells argillaceous sandstone fragments are associated with the oolitic material, becoming more abundant towards the west at the expense of oolitic sandstone. Thus, although the Bad Heart Sandstone proper is present

in the western part of the Clear Hills, the ferruginous oolite phase becomes more prevalent eastward, forming locally thick deposits, such as those at Worsley and Swift Creek.

In the southwestern part of the Chinchaga Hills the oolitic phase of the Bad Heart unit appears to be well developed and similar in character to the Swift Creek deposit, as evidenced by cutting samples from Richfield Oil Corp. Doig River No. 10-17 well (Lsd. 10, Sec. 17, Tp. 92, R. 10). However, no well log data are available to give a precise thickness for the unit, but the abundance of oolitic cuttings suggests that the bed may be of considerable thickness, perhaps as much as 20 feet. To the northeast the Bad Heart was observed in cutting samples from only a few wells (e.g., Shell Hotchkiss No. 29-93 well, Lsd. 7, Sec. 29, Tp. 93, R. 4), where it is present only as a thin, non-oolitic, silty unit.

Outcrop and subsurface data from the Milligan Hills are too scarce or lacking to determine whether the Bad Heart is present in the northwest part of the map-area.

Puskwaskau Formation

The Puskwaskau Formation consists of soft, grey, fissile shales of marine origin, estimated to be about 300 to 400 feet thick in the southern part of the map-area. The formation underlies the upper slopes of the highlands, but only small outcrops were observed in the Clear and Milligan Hills.

The basal shales of the formation outcrop above the Bad Heart oolitic sandstone exposures north of Worsley and on Swift Creek, and also on the Doig River in township 91, range 10. Two small outcrops less than 50 feet thick were also observed near the top of the Milligan Hills in township 99, range 11, and township 100, range 10, at elevations of about 3100 feet.

Wapiti Formation

The youngest Cretaceous rocks of the map-area are interbedded sandstones and silty shales of continental origin, equivalent to the lower part of the Wapiti Formation in the southern part of the Peace River district. The beds cap the southern portion of the Clear Hills, where they probably attain a maximum thickness of 400 feet, being overlain unconformably by unconsolidated gravels and glacial deposits. However, their assumed presence in the Chinchaga Hills to the north, as shown on the accompanying map, is based solely on extrapolation of structure contours and isopachytes of the underlying strata, for no outcrops of the Wapiti Formation were observed in this area.

The only observed outcrops of Wapiti strata within the map-area are present along the road leading to the Clear Hills fire tower on the southern edge of the Clear Hills. The upper 75 feet of the section consists

of soft, whitish, fine-grained sandstones up to 10 feet thick, interbedded with laminated siltstone and dark grey, silty shale. These beds are underl by a covered interval 50 to 100 feet thick, below which 15 feet of silty shales and carbonaceous sandstones containing a two-foot bed of impure c outcrop. These beds are assumed to be near the base of the formation but contact with the underlying Puskwaskau shale is covered.

Post-Cretaceous Deposits

Unconsolidated gravels of preglacial origin are exposed in roc cuts about the Clear Hills, Notikewin, and Doig fire towers in the southe part of the Clear Hills. The gravels consist of well rounded pebbles up to 6 inches in diameter, composed almost exclusively of fine-grained quartzi and chert. A few chert conglomerate pebbles resembling the Lower Cretaceous conglomerates of the Foothills to the west were also observed. Th gravels are similar in composition and texture to the preglacial gravels wh cap many of the residual highlands in other parts of the province, but thei thickness, distribution, and age within the map-area are not known.

Glacial deposits of variable thickness cover the entire region although they are seldom well exposed. They consist largely of pebbly cl till forming ground and hummocky dead-ice moraine, or sparsely pebbly lacustrine clay of proglacial origin (Bayrock, in Lindsay et al., 1959). Thick outwash deposits also were observed in the wide, glaciated valleys the streams draining the southern slopes of the Milligan Hills, and on the glaciated lowlands in the southeast part of the map-area, along the Notik and Whitemud Rivers. These deposits consist of well sorted, crossbedded, pink, feldspathic sand with thin pebble lenses. The exposures are from 25 to 100 feet thick and are overlain by unstratified pebbly clays resembling

STRUCTURE

The structural configuration of the strata is primarily that of a gentle anticlinal bend or terrace, with the steeper limb lying in the south western one-half of the region. Regional dips are all extremely low, nowhere exceeding 15 feet per mile.

Structure contours drawn on the contact between the Shaftesb lower and upper members indicate a regional dip to the southwest of 12 fe per mile on the steeper limb, and of 4 feet to the mile to the southwest on the more gentle northeast limb (Fig. 5). Local rolls or reversals of dip ap parently are present along the northwest-trending apex of the flexure, an the largest structure is a low asymmetrical dome with a maximum amplitud of 150 feet, centred in township 95, range 5.

The effect of stratal thickness changes on the structural confi is apparent in a comparison of structure contours drawn on the top of the Dunvegan Formation with those on the lower-upper Shaftesbury contact. the south half of the map-area the regional dip of the Dunvegan surface i

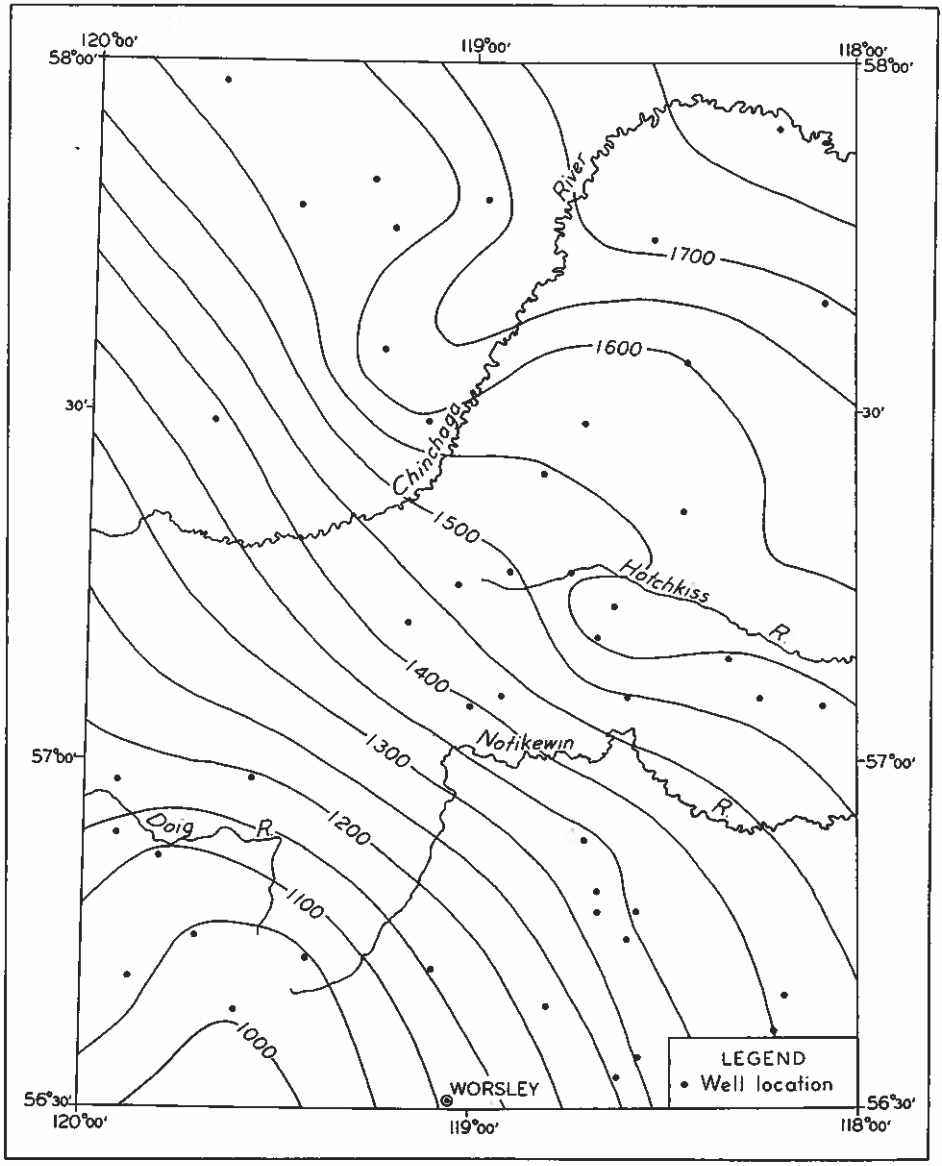

Figure 5. Structure contour map of the top of the lower member of the Shaftesbury Formation.

to the south at 8 feet per mile, and the surface is essentially flat-lying in the northeast quarter of the area. (No control data were obtained for the northwest quarter of the region). The northeastward thinning of strata of the upper Shaftesbury and Dunvegan units thus induces a significant reduction in the magnitude of the regional dip.

Steep dips visible in some outcrops are induced by ubiquitous local slumping.

No evidence of faulting was noted, but because of the paucity of control points, the possibility of its presence cannot be excluded.

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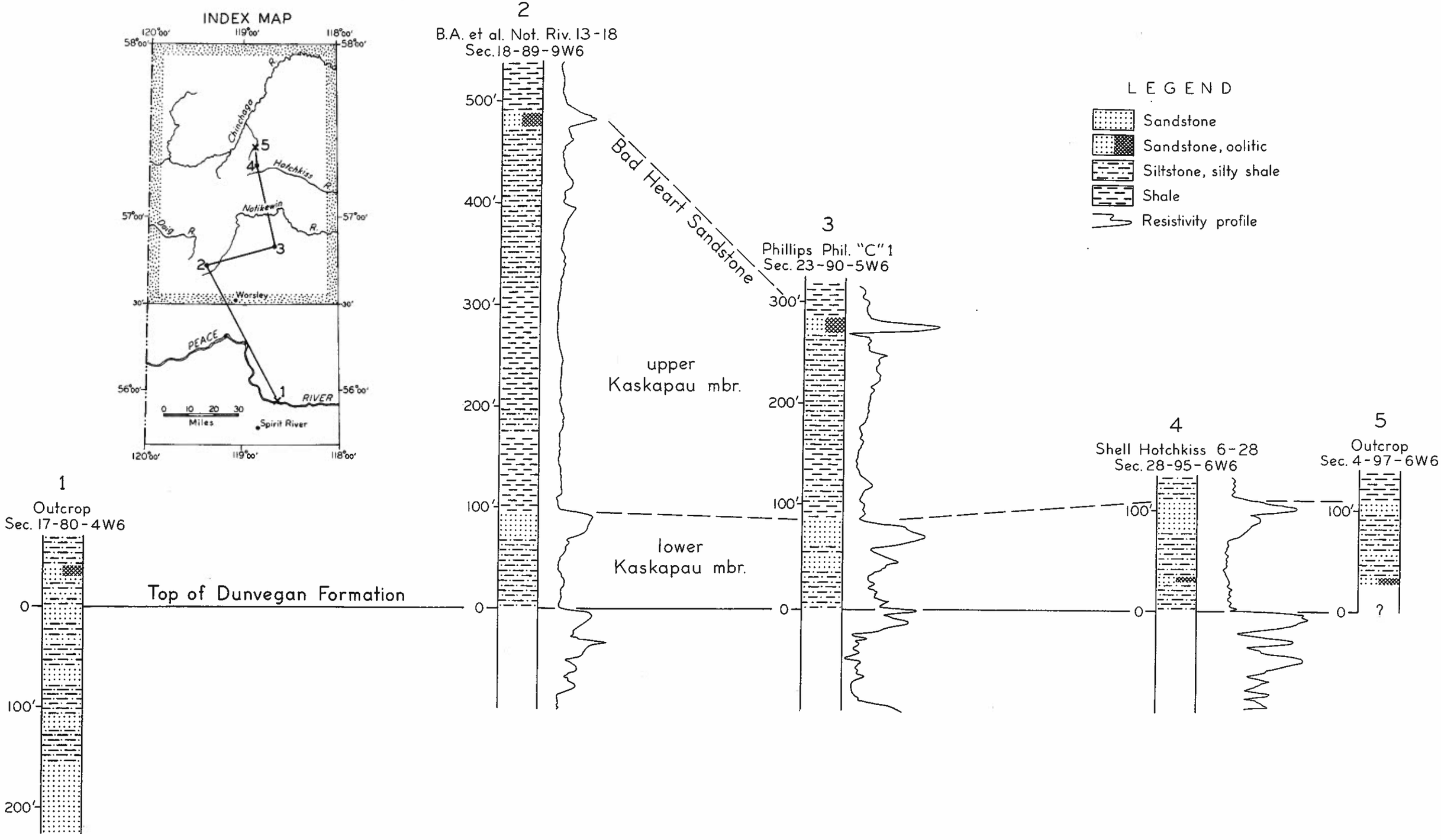

Figure 3. Columnar sections showing the stratigraphic loci of iron-rich beds in northwestern Alberta

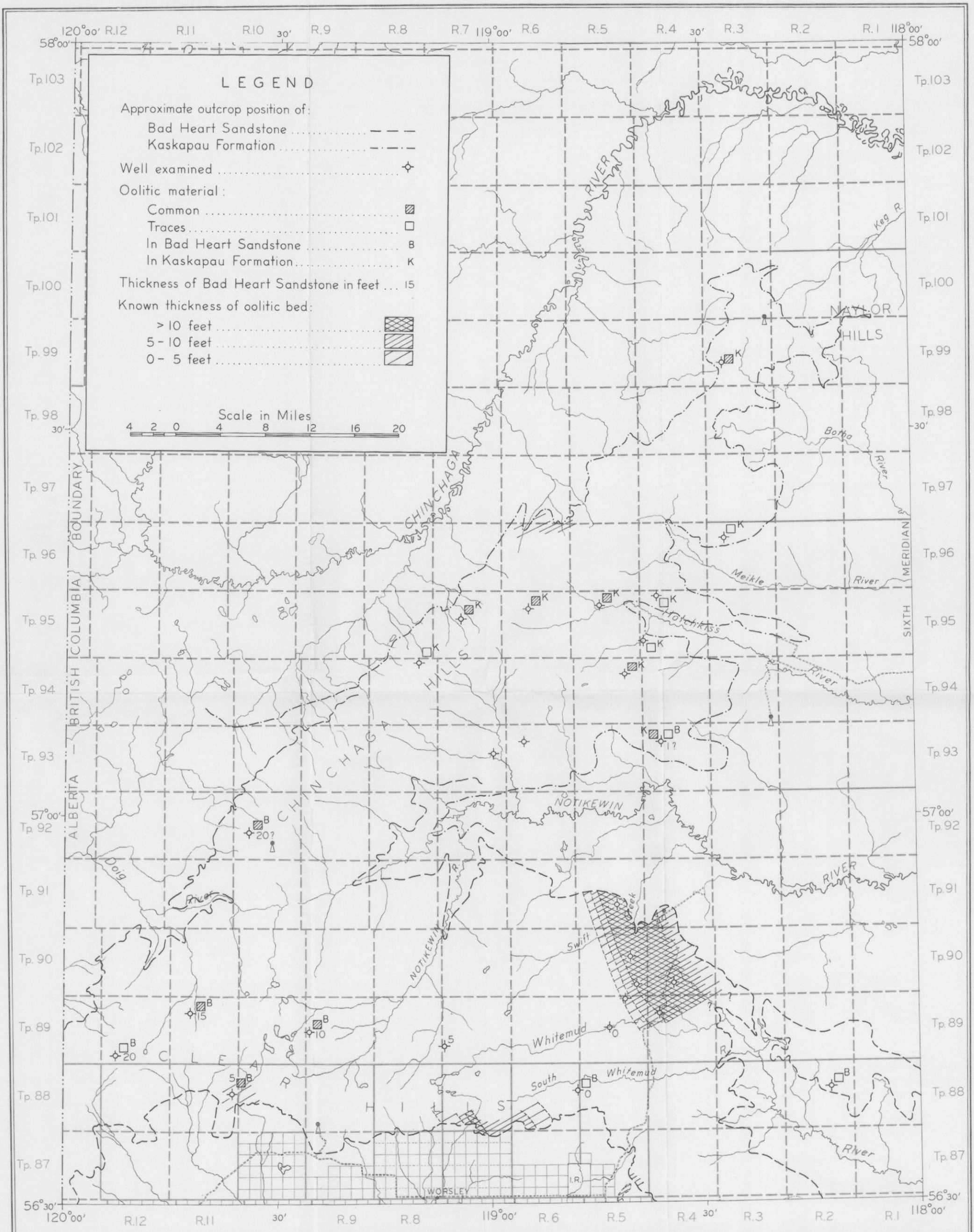

Figure 4. Distribution and known thicknesses of oolitic beds in the Smoky River Group in the Clear and Chinchaga Hills.

(Isopachs for the Swift Creek and Worsley areas were derived from drill-hole data of Peace River Mining and Smelting Co. Ltd.).

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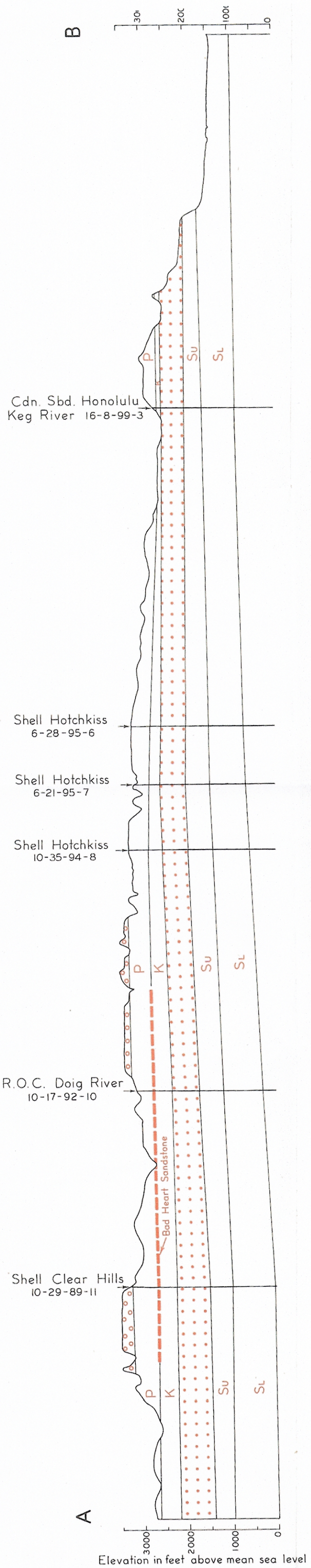

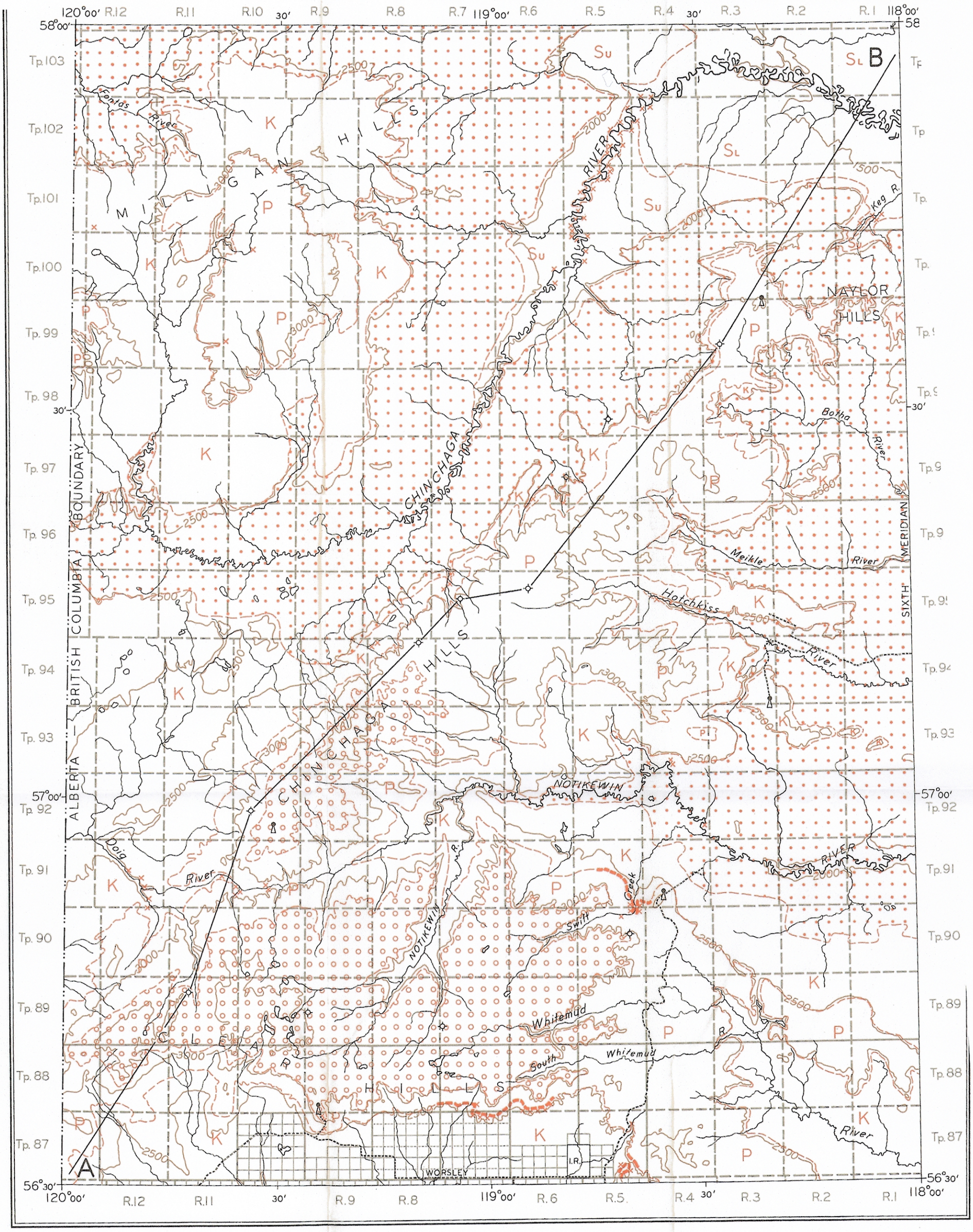

GEOLOGY

CHINCHAGA RIVER AND CLEAR HILLS (NORTH HALF), ALBERTA

Scale in Miles

4 2 0 4 8 12 16 20

L E G E N D

- Wapiti Formation
- P — Puskwaskau Formation
- Bad Heart Sandstone
- K — Kaskapau Formation
- Dunvegan Formation
- Su — Upper
- Sl — Lower
- } Shaftesbury Form.

- Outcrop ×
- Oil well ⊹
- Lookout tower
- Road, (all weather) ------
- Contour, (Elevation in feet above mean sea level; contour interval 500 feet) (1500)

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