Quaternary Stratigraphy
of
Central Alberta

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INTRODUCTION

The area of study (indicated in Figure 1) is a critical area for Quaternary stratigraphy studies for the following reasons:

1. Surficial mapping programs have been completed on the entire area thus providing continuous coverage between areas of confirmed Cordilleran and Rocky Mountain glaciation in the west and continental glaciation to the east. This is one of the first such documented cases in the province.

2. Studies within the area afford some appreciation of the relationships between separate lithological units both in a vertical and lateral stratigraphic sense.

Drainage systems, main access routes and principal urban centres are shown in Figure 2.

PHYSIOGRAPHY

Seven main physiographic areas are recognized (see Figure 3, after Boydell, 1972 and Stalker, 1960). The Brazeau and Ram Ranges in the southwest part of the study area achieve elevations of up to 8000 feet. The topography is rugged forming northwest-southeast orientated mountain ranges which are breached by the North Saskatchewan, Ram and Clearwater Rivers. The Elk Creek basin lies at an elevation of about 5500 feet between the ranges.

The Brazeau Piedmont forms a broad plateau on the eastern flanks of the Brazeau Range with elevations averaging approximately 4500 feet. The Piedmont adjoins the undulating Western Highland region to the east which has elevations varying between 3000 and 4000 feet. The Red Deer Lowland forms a narrow plain through the central part of the area with an average elevation of about 2800 feet. Further to the east is the Central Highland which varies from level to very rolling topography up to 3500 feet in elevation. Major features superimposed on this region include the expansive plain in the Drumheller area, the deeply incised valley of the Red Deer River, the Hand Hills and Wintering Hills. The Torlea Flats constitute the most easterly physiographic division and it is typically flat to gently rolling with elevations averaging 2300 feet.

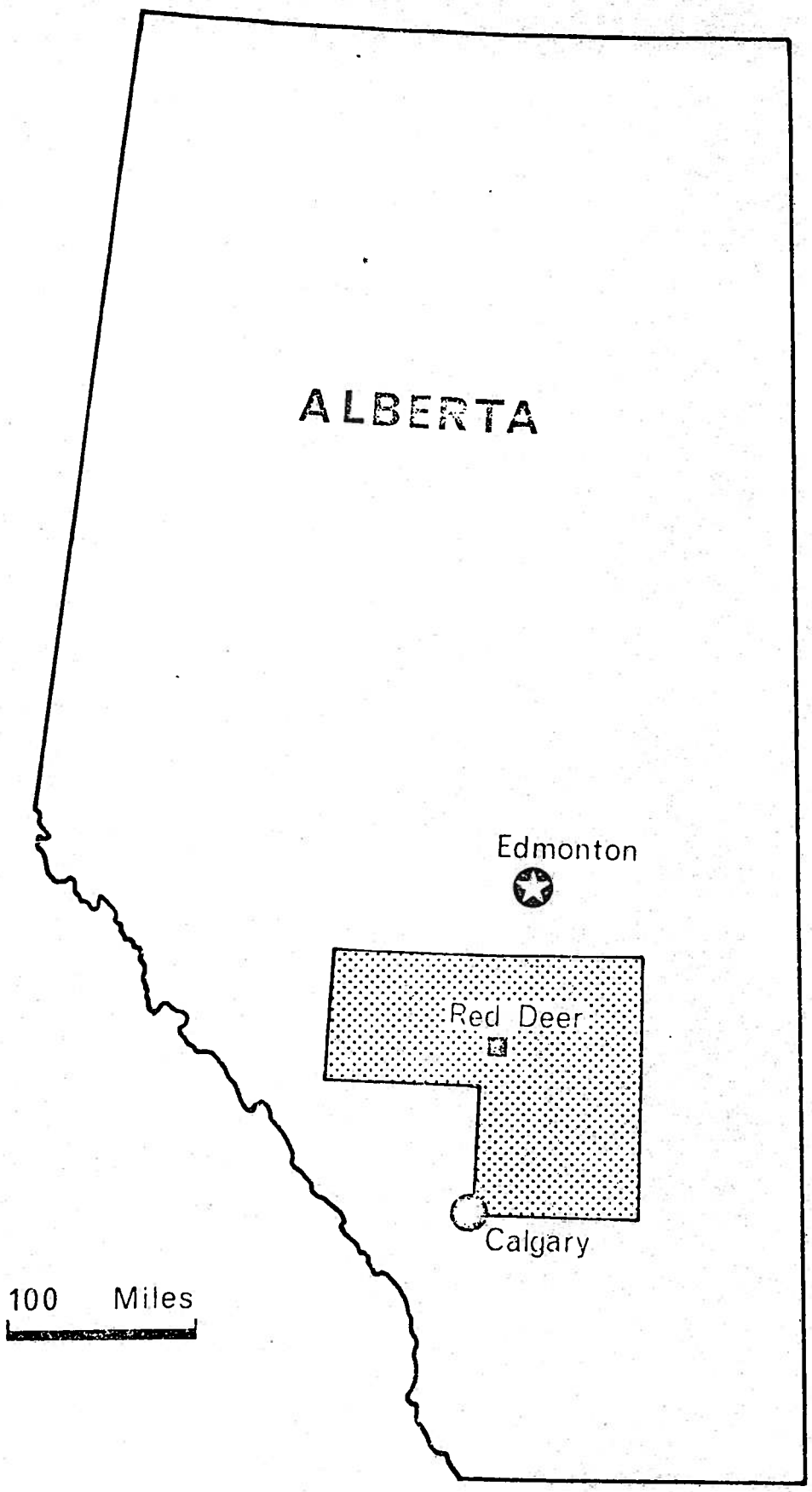

Figure 1 - LOCATION MAP

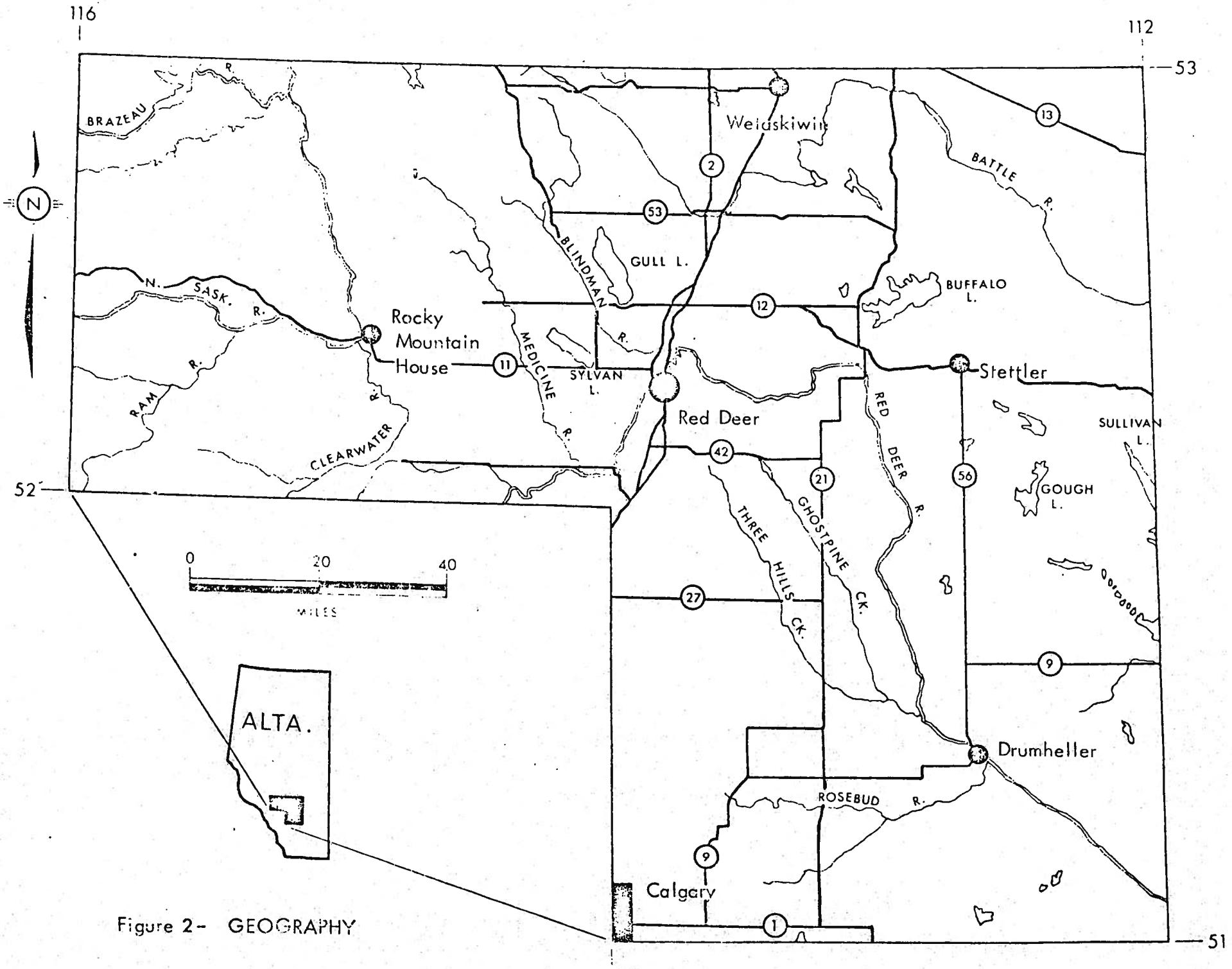

Figure 2- GEOGRAPHY

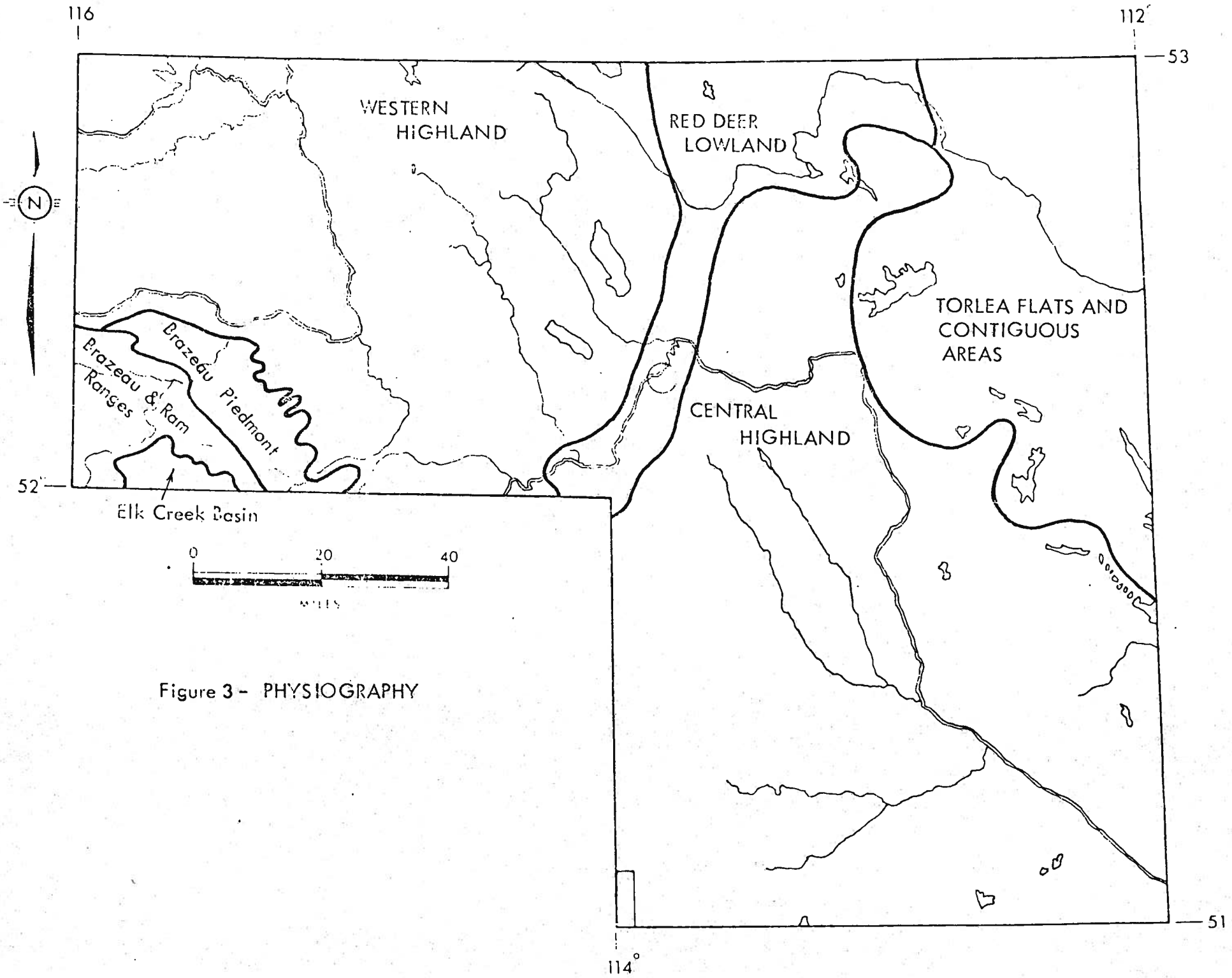

Figure 3 - PHYSIOGRAPHY

BEDROCK GEOLOGY

The southwest part of the study area is included in the Outer Foothills belt of the Cordilleran region (Figure 4, after Green, 1972). Strata ranging from Paleozoic to Tertiary in age have been thrust east to form outliers of the main Rocky Mountain Ranges. The beds normally dip west at angles of 30° or less and are commonly folded and overturned adjacent to major thrust faults. The most easterly of the main thrust faults is the Brazeau Thrust which delimits the edge of the Foothills. The remainder of the area is underlain by Upper Cretaceous and Tertiary beds which occur along the western margin of the Alberta Basin and dip to the west at low angles.

PREGLACIAL VALLEYS

Figure 5 delineates preglacial valleys east of the Foothills (Carlson, 1969, 1970; Farvolden et al., 1963). The Red Deer River and its tributaries in the Drumheller area may correspond to the positions of preglacial valleys although some controversy surrounds this interpretation. Drainage patterns in the north part of the area were directed to the east whereas river systems flowed southeasterly in the southern portion of the area.

GLACIAL GEOLOGY

The surficial geology of the entire area has been mapped and the coverage of individual workers is given in Figure 6. Mapping by Bayrock, Reimchen and Boydell is complete but remains unpublished to date. The writer obtained access to preliminary material in the files of the Research Council.

A simplified composite map of the glacial geology is given in Figure 7. Pleistocene and Recent alluvium, aeolian deposits, bedrock exposures and areally restricted glacial features have been eliminated.

QUATERNARY STRATIGRAPHY

The definitive stratigraphy is best confined to a description of individual tills (Figure 8). Boydell (1972) recognized six major tills and four were interpreted to be

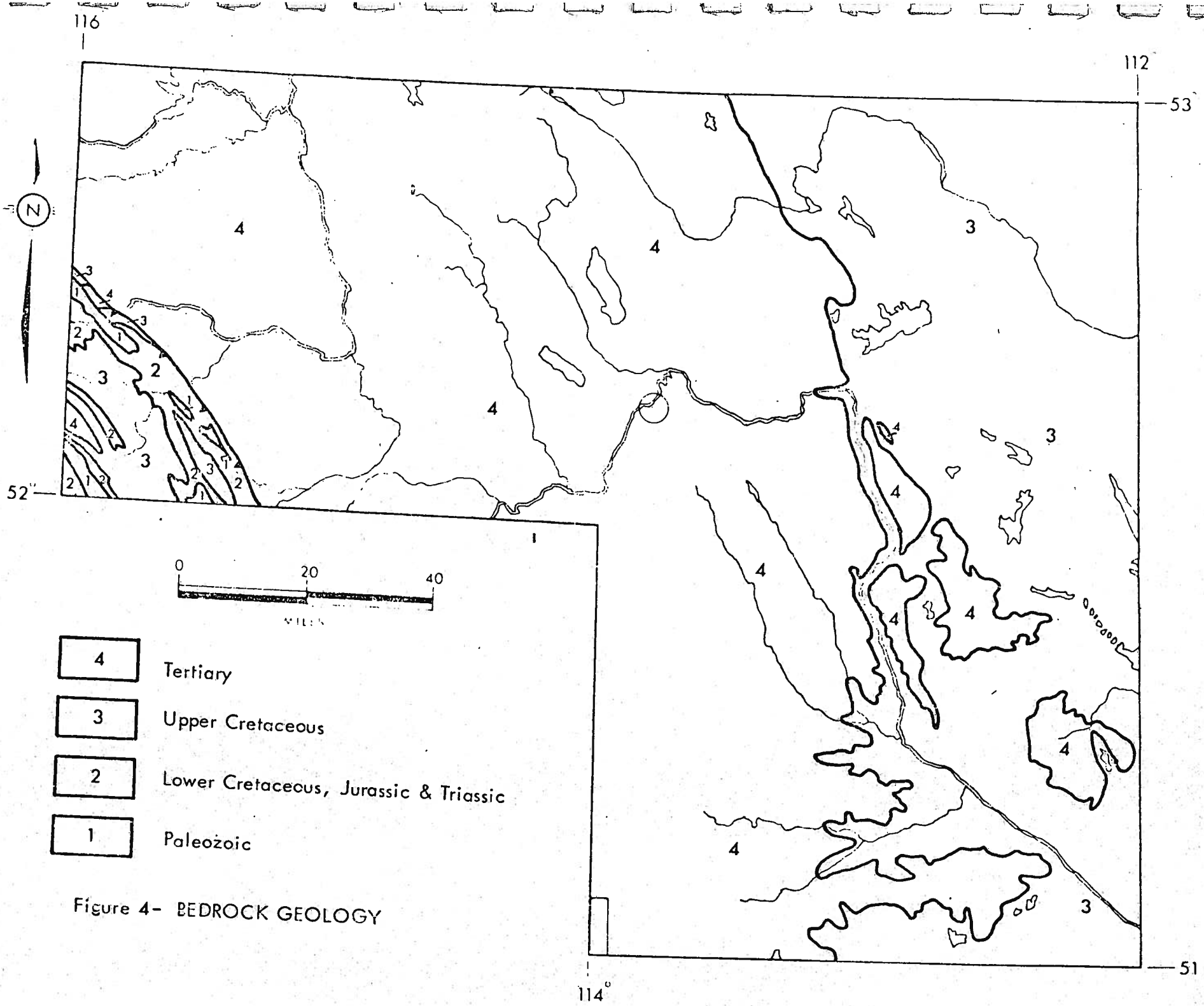

Figure 4- BEDROCK GEOLOGY

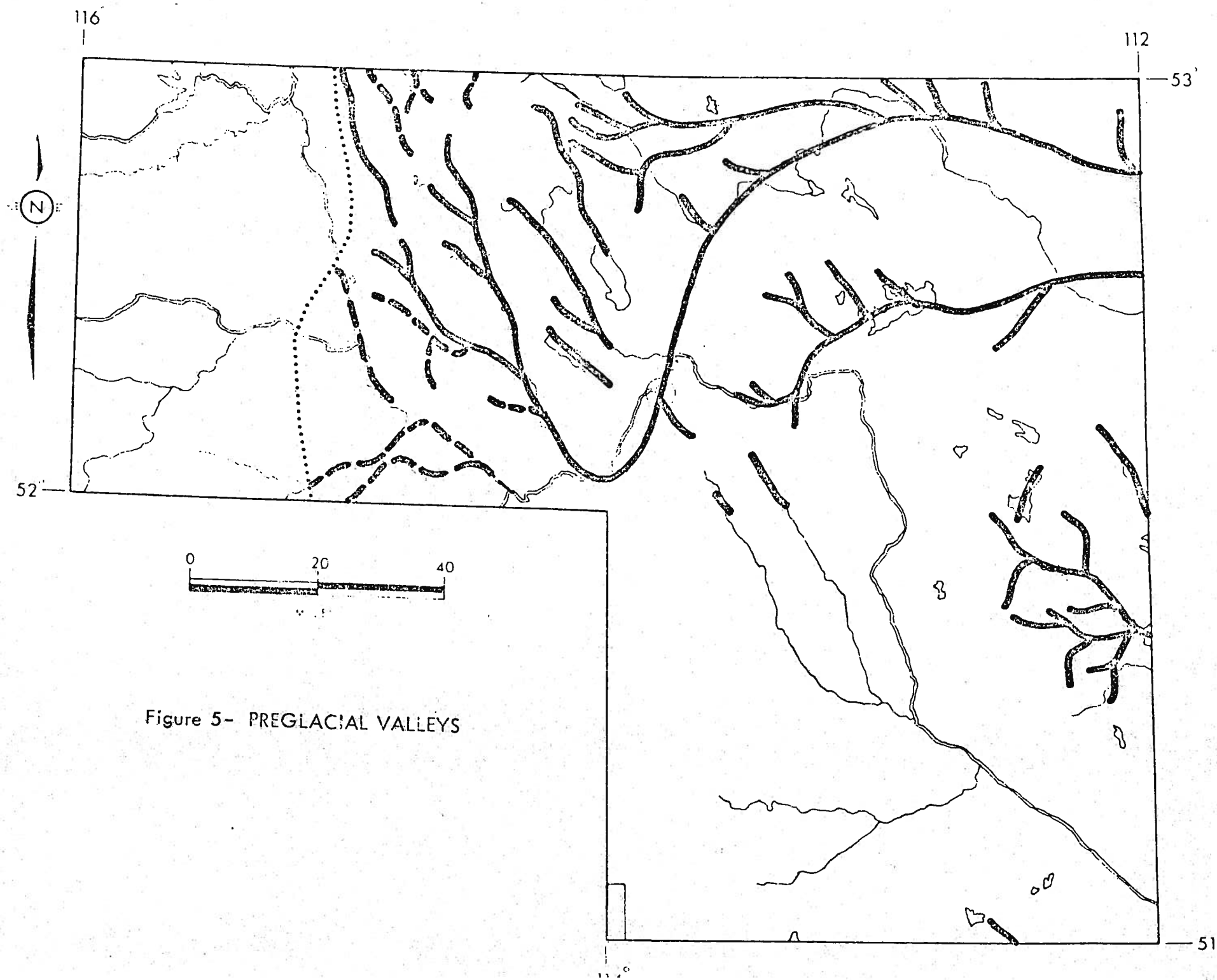

Figure 5- PREGLACIAL VALLEYS

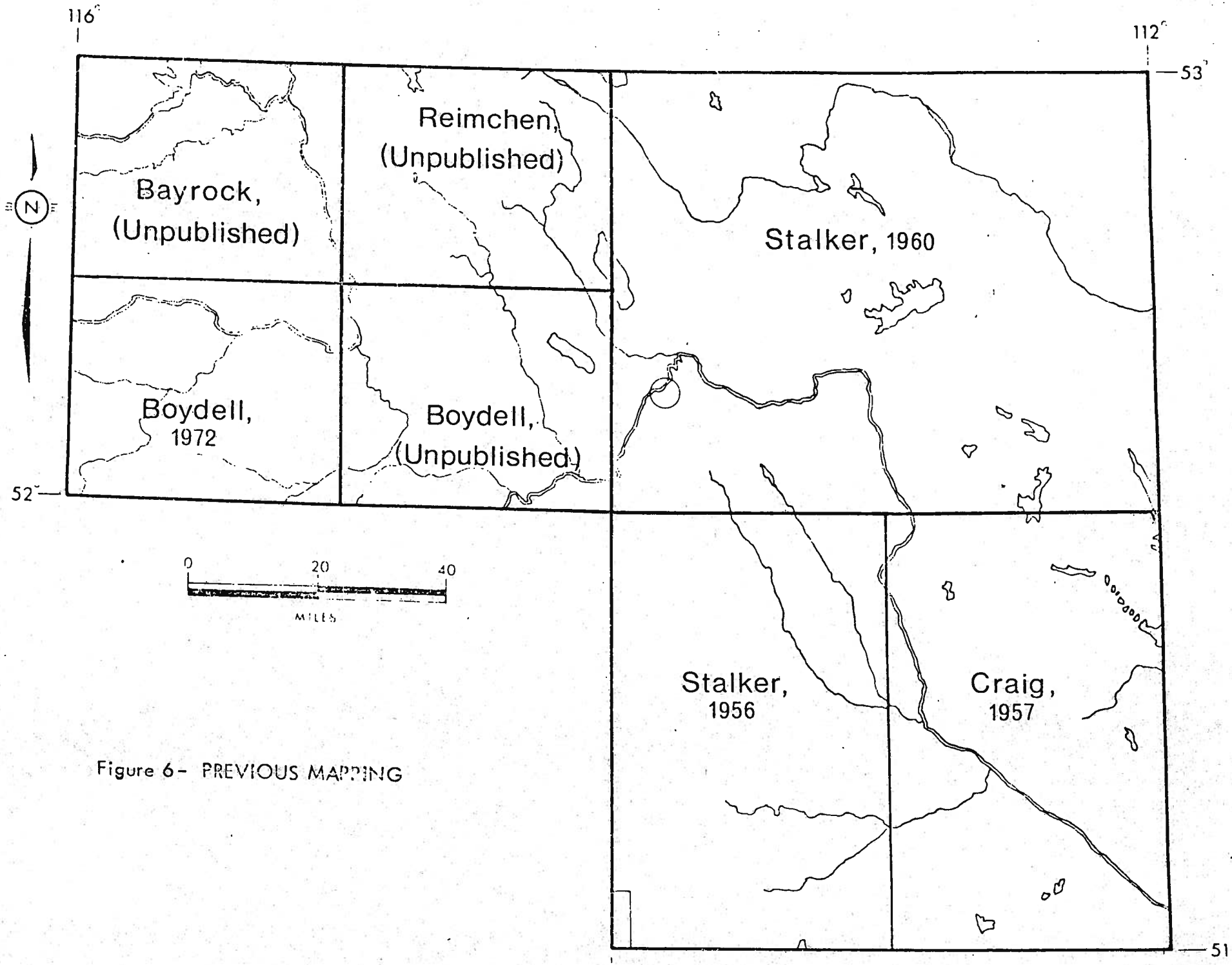

Figure 6- PREVIOUS MAPPING

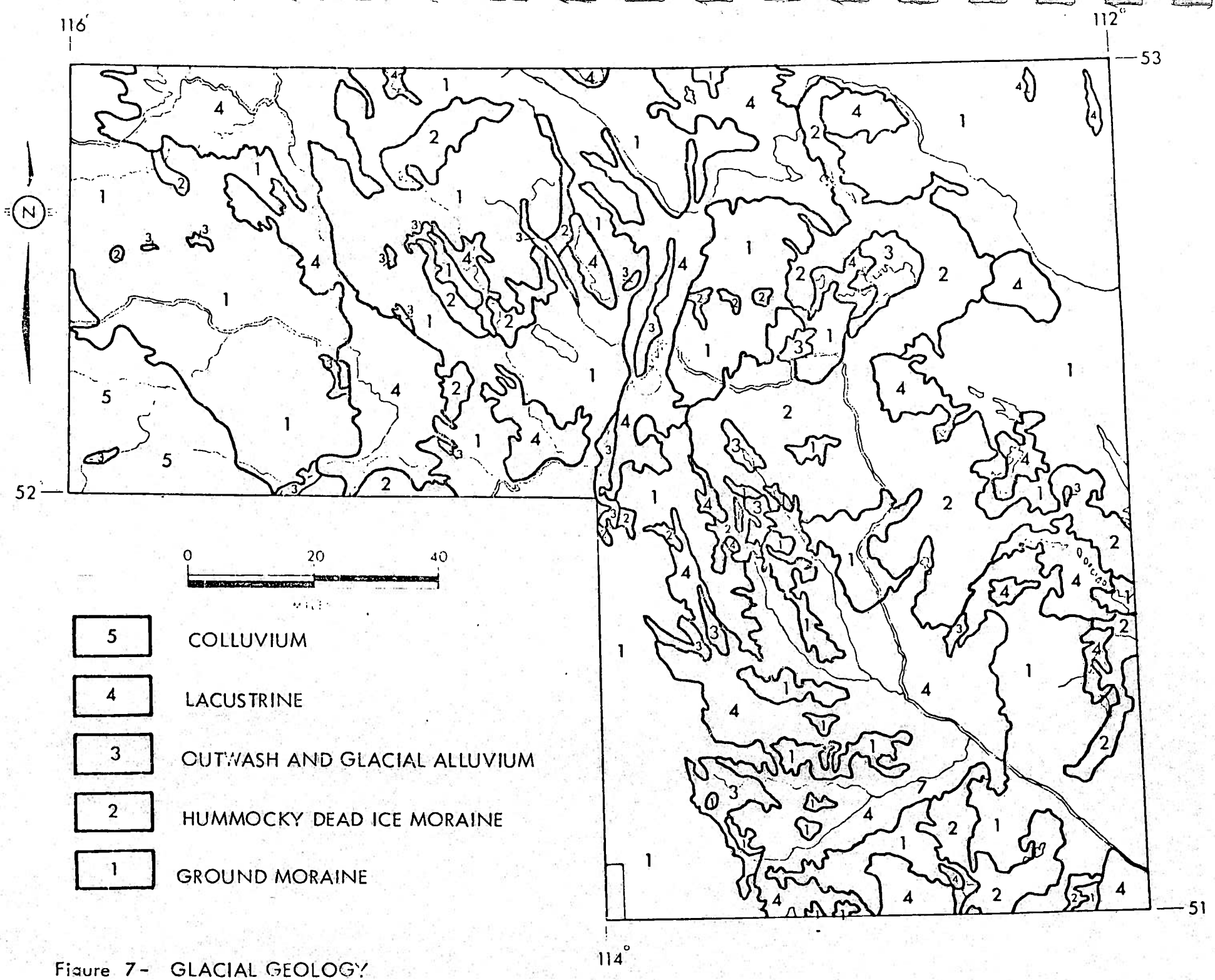

Figure 7 - GLACIAL GEOLOGY

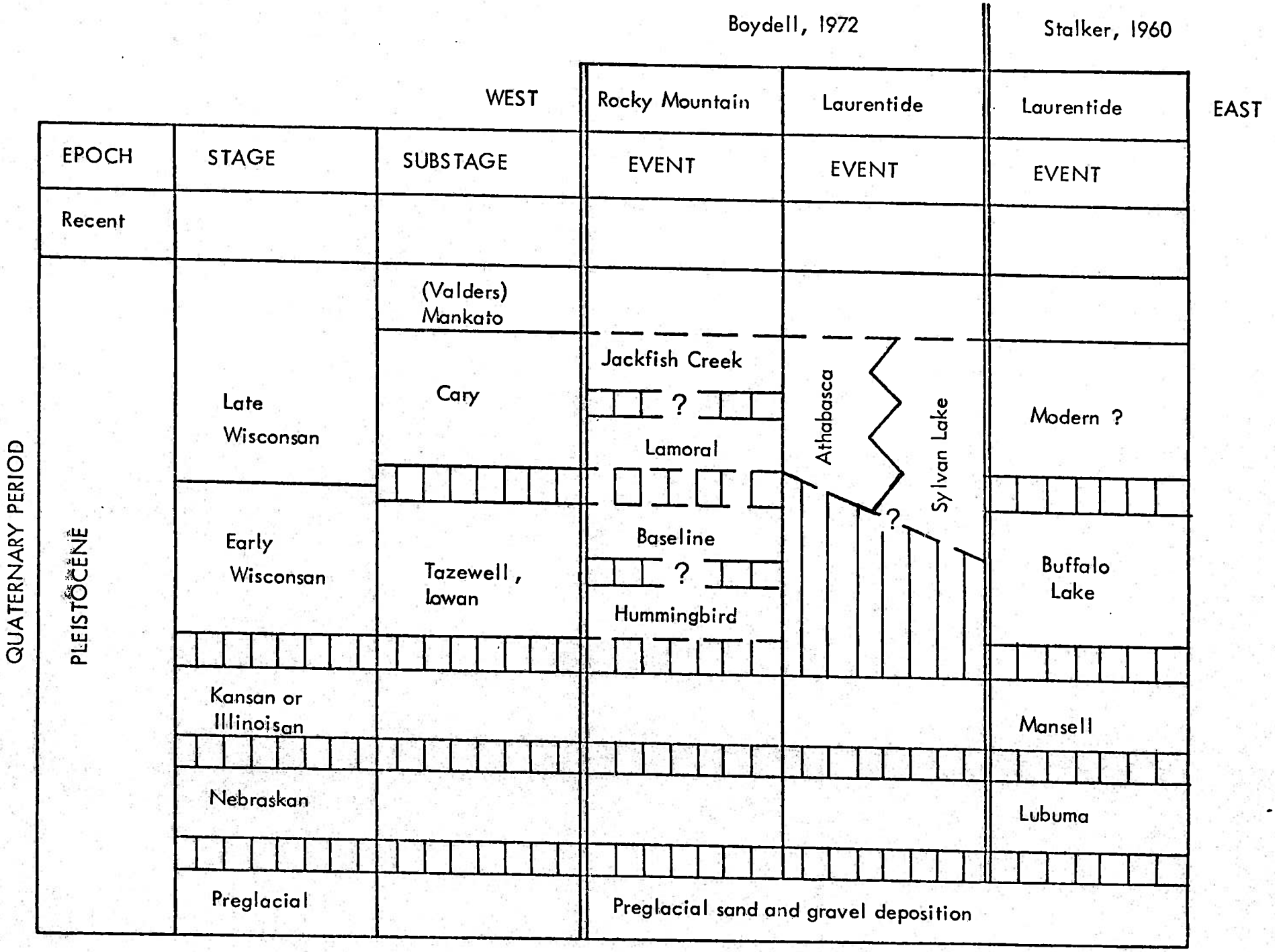

Figure 8 - QUATERNARY STRATIGRAPHY

derived from Rocky Mountain* glaciation,

one from Laurentide (continental) glaciation, and one from mixed glaciation. Stalker (1960) defined three main tills in the Red Deer area. Distinguishing characteristics and location of type sections are as follows:

Labuma Till - Good exposures are found on the Red Deer River near the city of Red Deer in Sec. 19, Tp. 38, Rge. 27 W4 (Locality A, Figure 9). Stalker describes the till as dark blue or black in color and carbonaceous. It contains scattered stones from the Cordillera, Precambrian Shield and local bedrock.

Maunsell Till - Stalker recognized this unit at the above locality although the type section occurs in the NW1/4, Sec. 18, Tp. 7, Rge. 28 W4, well outside the study area (Horberg, 1952). The Maunsell till is light to dark blue, carbonaceous and contains scattered pebbles from the Cordillera, Precambrian Shield and local bedrock.

Buffalo Lake Till - Several good exposures of this till are located in hummocky moraines in the Buffalo Lake area. It is variable in color from brown, yellow, grey and light blue, where unoxidized. Sections may contain pebbles derived from the Precambrian Shield or from mixed Cordilleran, Precambrian Shield, and local bedrock sources.

No formal recognition is given to a younger till than the Buffalo Lake. However, sections described by Stalker include so-called "Modern" tills. A reconstruction of events of deglaciation by Stalker allows for a final weak readvance which may account for the adoption of the terminology.

Hummingbird Till - The main deposit is located in Sec. 25, Tp. 36, Rge. 16 W5 and the type section occurs immediately below the upper falls on the South Ram

*Boydell utilized the term "Rocky Mountain" glaciation to distinguish effects of glaciers originating in areas east of the Continental Divide from Cordilleran glaciation caused by glaciers originating from west of the Divide.

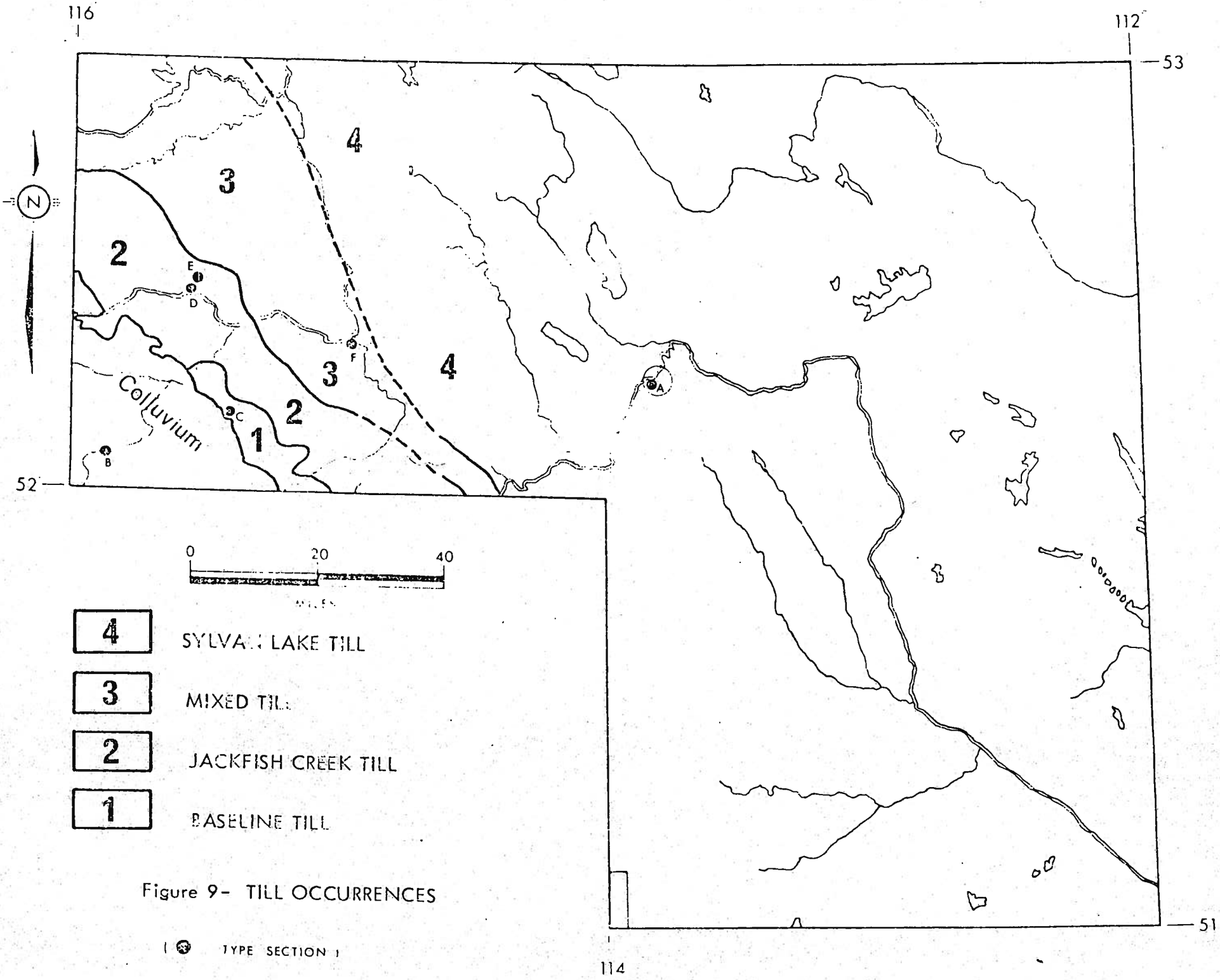

Figure 9- TILL OCCURRENCES

River (Sec. 8, Tp. 36, Rge. 14W5 - Locality B, Figure 9). The till is buff to light brown, well cemented by calcite throughout, and the pebble lithology is predominantly carbonates.

Baseline Till - The type section is located in Sec. 19, Tp. 37, Rge. 10W5 (Locality C, Figure 9) and is found only on the plateau of the Brazeau Piedmont. The material is extensively oxidized and carbonates have been leached to a depth of at least 7 feet. The principal pebble lithologies are chert, quartzite and sandstone. The latter is believed to be derived from outcrops of the Lower Cretaceous Cadomin Conglomerate flanking the Brazeau Range.

Lamoral Till - This till outcrops in the type section of the Lamoral Advance deposits in Sec. 20, Twp. 40, Rge. 11W5 near the ghost town of Lamoral (Locality D, Figure 9). Pebble lithologies consist principally of carbonates and quartzites (including Lower Cambrian Gog Group orthoquartzites). Unweathered material is dark grey and compact. Heavy minerals confirm a Rocky Mountain origin with twice the percentage of garnet as the overlying Jackfish Creek till.

Jackfish Creek Till - The type section is named after Jackfish Creek where it is crossed by the David Thompson Highway (Sec. 32, Twp. 40, Rge. 11W5; Locality E, Figure 9). The till is silty or sandy and greyish brown to dark brown in color in the unweathered zone. Leaching of carbonates is commonly in the order of 3 feet in depth. Pebble lithologies are composed largely of carbonates and quartzites (including the Gog orthoquartzite) and Mesozoic sandstones. The latter tend to form a lower percentage of the pebbles eastwards from the Brazeau Range.

Athabasca Till - This till is named after the Athabasca valley region and was first described by Roed (1968). It represents mixed characteristics of Cordilleran and Laurentide glaciation. Boydell established a type section at an exposure on the south side of the North Saskatchewan River in Sec. 8, Tp. 39, Rge. 7W5 (Locality F, Figure 9). The material is grey brown in the unweathered zone and

has a relatively high sand content. The presence of garnet talcose schist pebbles indicate a Cordilleran source in part whereas granites and high-grade metamorphic rocks derived from the Canadian Shield confirm Laurentide influences.

Sylvan Lake Till - No type section is established for the Sylvan Lake till. It is variable in color, ranging from an oxidized medium brown, through unweathered grey, to a yellow green near the base. The till is sandy and stony, the principal pebble lithologies being quartzites and Shield-derived rocks.

Stalker interprets the Labuma, Maunsell and Buffalo Lake tills as being deposited during distinctly different glacial advances. The Labuma and Maunsell are regarded as pre-Wisconsin. Little evidence is cited for a post-Buffalo Lake till deposit.

Hummingbird/Baseline, Lamoral and Jackfish Creek tills are believed to represent separate Cordilleran or Rock Mountain glacial advances on the basis of distinctive morphology, pebble lithologies and the inferred directions of ice movement. The Baseline till has no demonstrable stratigraphic contact with any other glacial deposit in the area. The contact of the Jackfish Creek till with the Athabasca till is poorly defined. No evidence has been found for superposition of these two tills. Furthermore, they have sufficiently distinctive pebble lithologies and heavy mineral suites to conclude that separate ice sheets were involved.

Athabasca till grades laterally into Sylvan Lake till. This is confirmed by stratigraphic and morphological continuity of the tills as well as gradational changes in the composition of pebble lithologies. Neither unit overlies the other and Boydell concludes that Athabasca till is a lithofacies of Sylvan Lake till, both being deposited by the same glacial advance.

Stratigraphic studies have not been conducted between 114° and 115° longitude within the study area. However, it is assumed for the same reasons outlined above, that the Sylvan Lake till is stratigraphically equivalent to the Buffalo Lake till. A late advance suggested by Stalker (the Innisfail rejuvenation) complicates the complete correlation of the Buffalo Lake till with units to the west.

GLACIAL HISTORY

Figures 10 to 15 summarize the final deglaciation events. Phases of maximum glacial lake development are presented rather than the many intermediate events, to best describe proglacial sedimentation and drainage patterns.

Figure 10 illustrates the relationships between maxima of Jackfish Creek and Laurentide ice. Rocky Mountain glaciers were deflected from eastward movement towards the southeast by Laurentide ice advancing south.

Glacial Lake Caroline resulted from deterioration of Jackfish Creek ice and ponding along the western edge of the continental glacier (Figure 11). Drainage was effected by means of several spillways along the southern margin of the lake.

Glacial Lakes Medicine and Chancellor are regarded herein to be contemporary (Figure 12), but this is not confirmed by the literature. The Hand Hills and Wintering Hills became ice-free at approximately the same time as Lake Chancellor accumulated (Craig, 1957). Drainage was to the south and southeast.

The Glacial Lakes Red Deer - Drumheller phase (Figure 13) resulted in lake development in basins which possibly remained as a result of preglacial erosion. As the ice front progressively melted east in the Drumheller area small lakes were ponded at the headwaters of individual stream systems such as the Ghostpine and Three Hills Creeks until they merged in the main configuration indicated. Drainage progressed to the south and at this time downcutting of the Red Deer River valley east of the city of Red Deer was initiated.

The next major phase of deglaciation led to the ponding of several small glacial lakes as indicated in Figure 14. By this time the Red Deer River system was well developed across the entire study area.

The final deglaciation event (Figure 15) resulted in development of Glacial Lakes New Norway and Red Willow. Drainage paralleled the ice front and also continued to feed into the Red Deer River system.

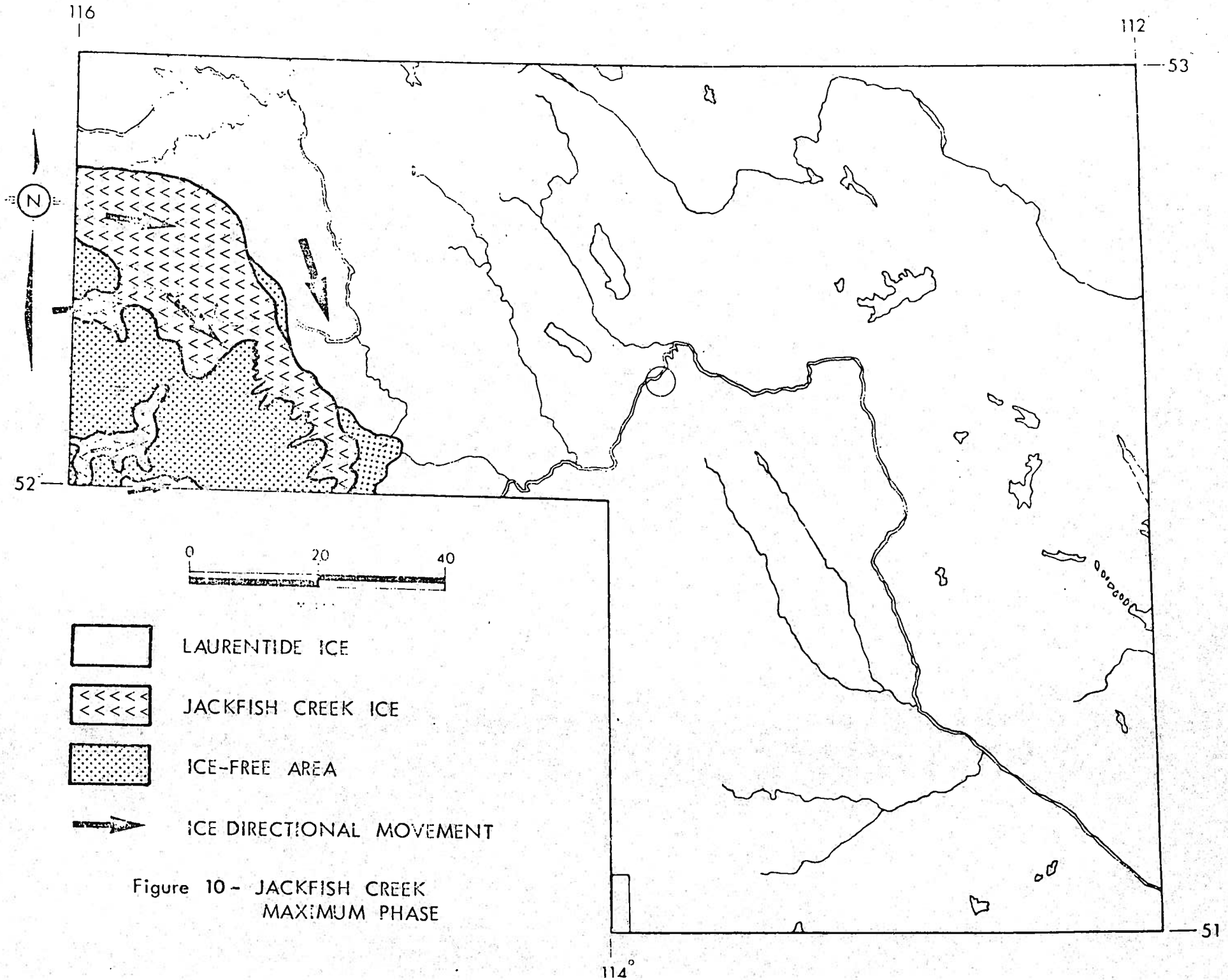

Figure 10 - JACKFISH CREEK MAXIMUM PHASE

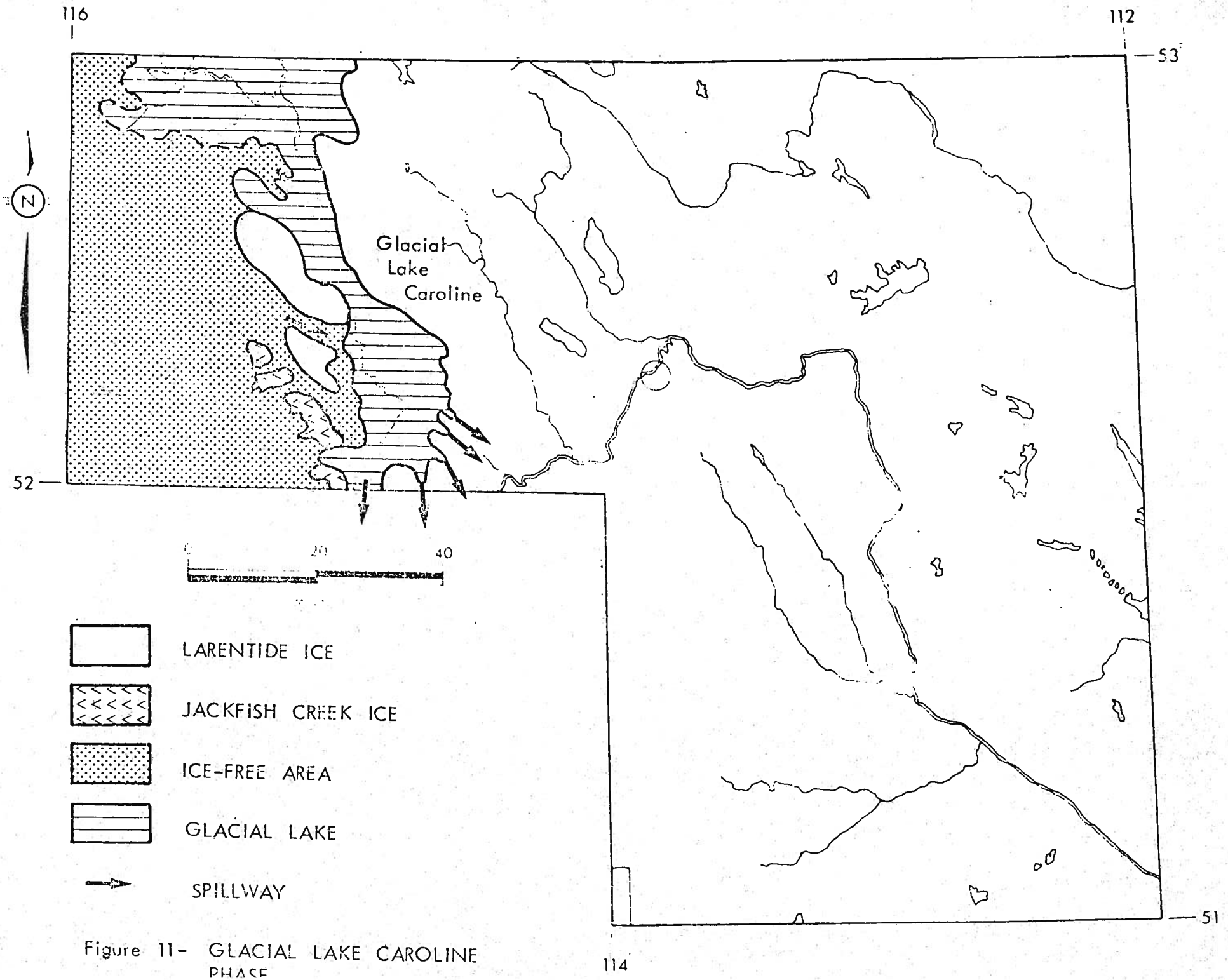

Figure 11- GLACIAL LAKE CAROLINE PHASE

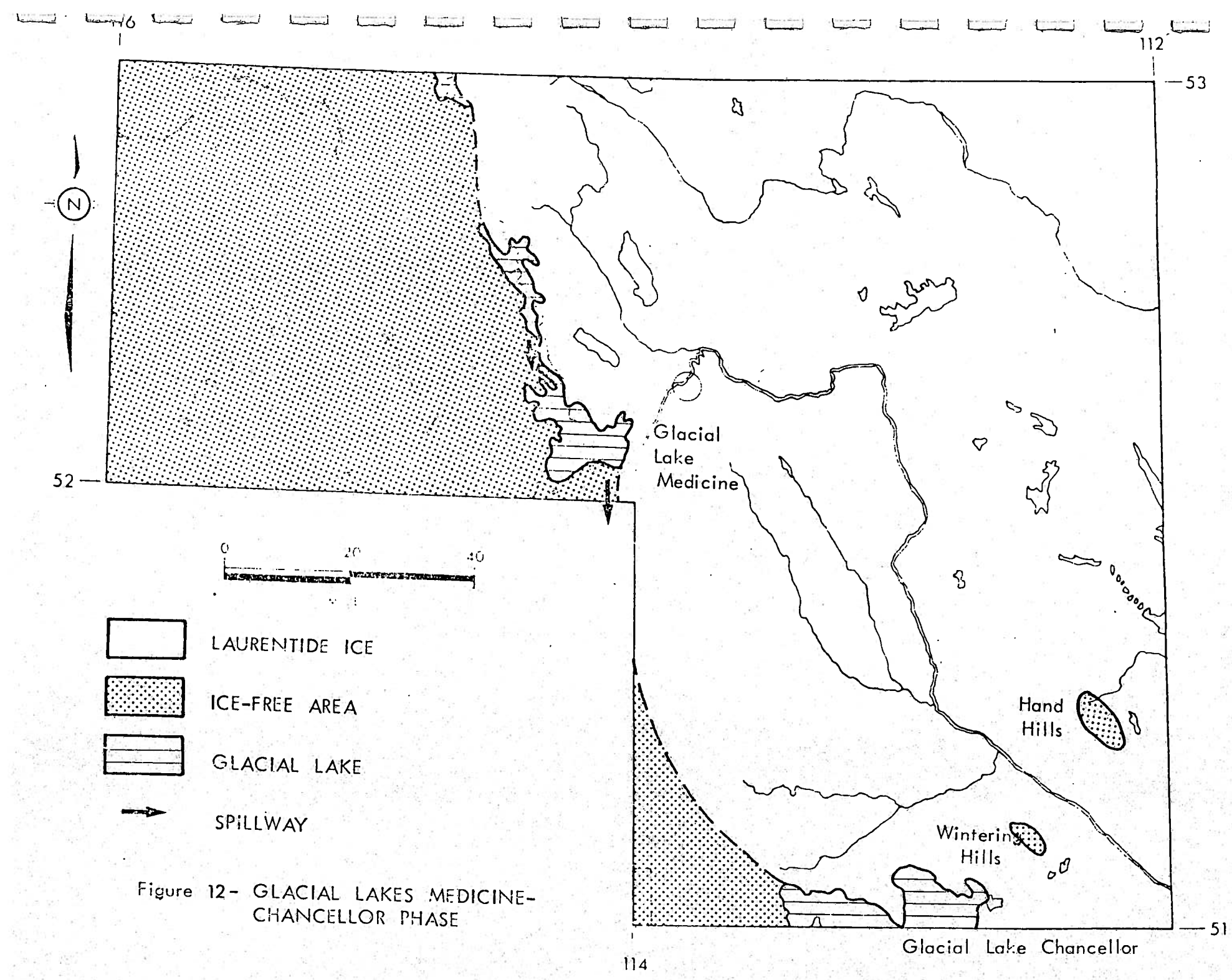

Figure 12- GLACIAL LAKES MEDICINE-CHANCELLOR PHASE

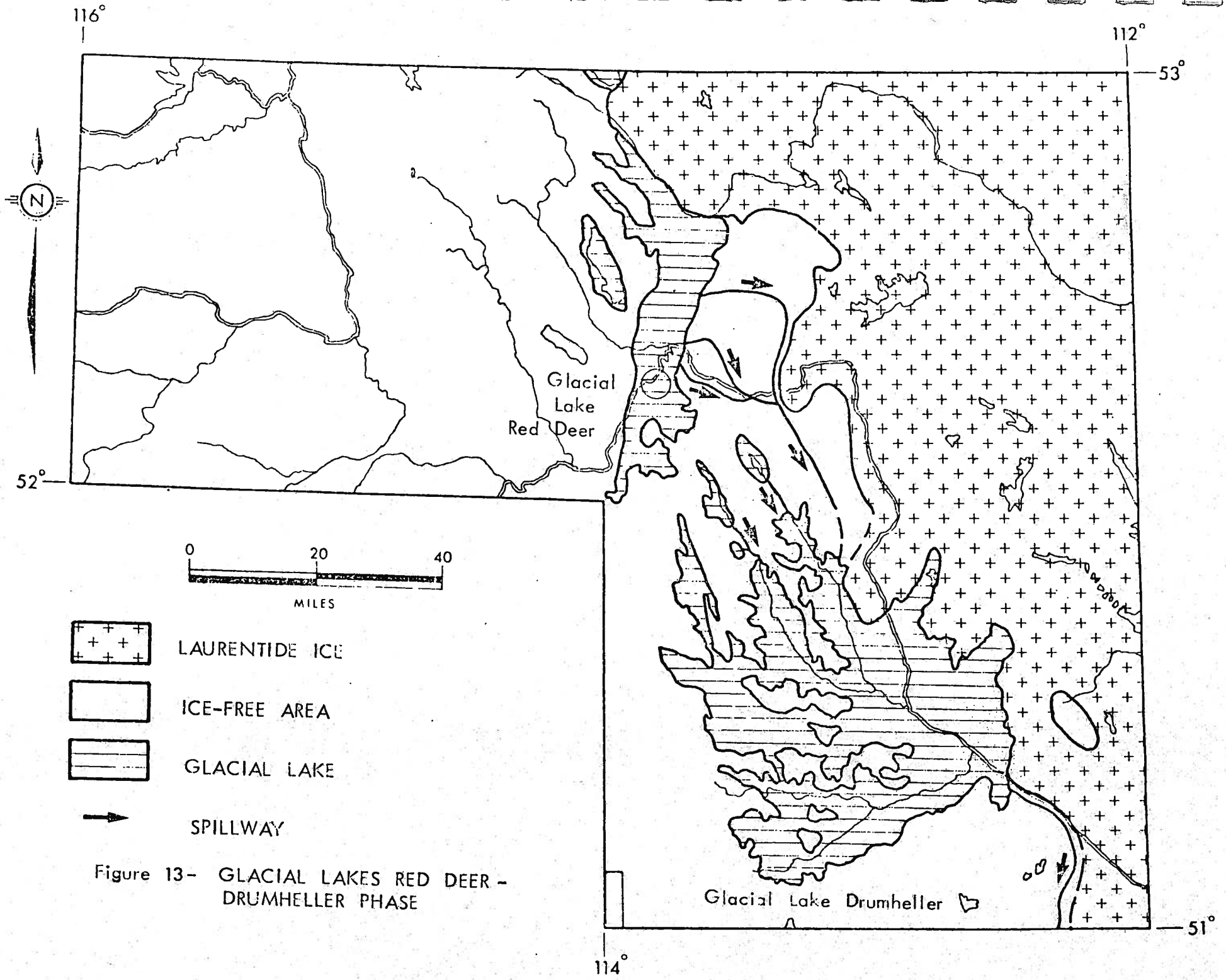

Figure 13- GLACIAL LAKES RED DEER - DRUMHELLER PHASE

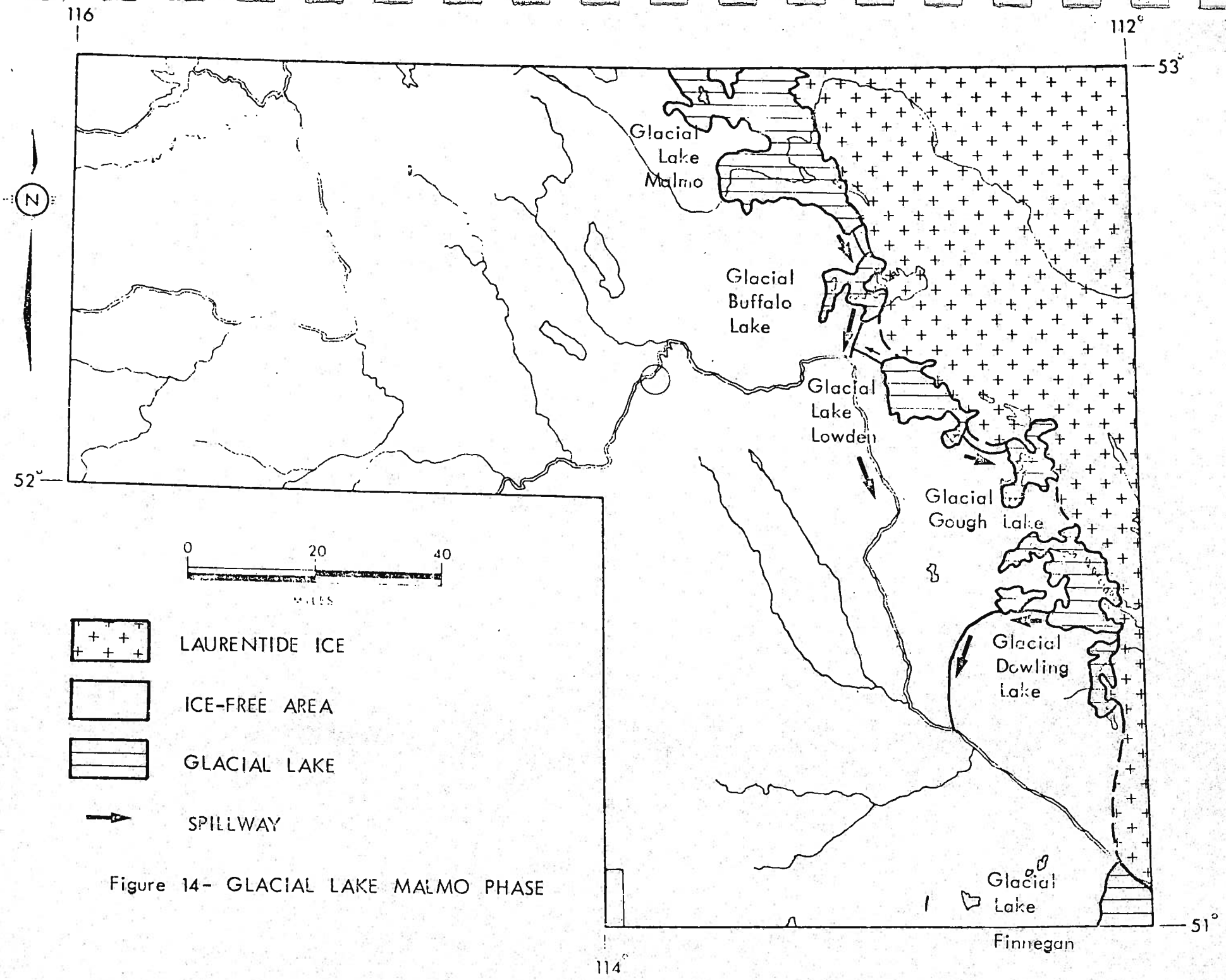

Figure 14- GLACIAL LAKE MALMO PHASE

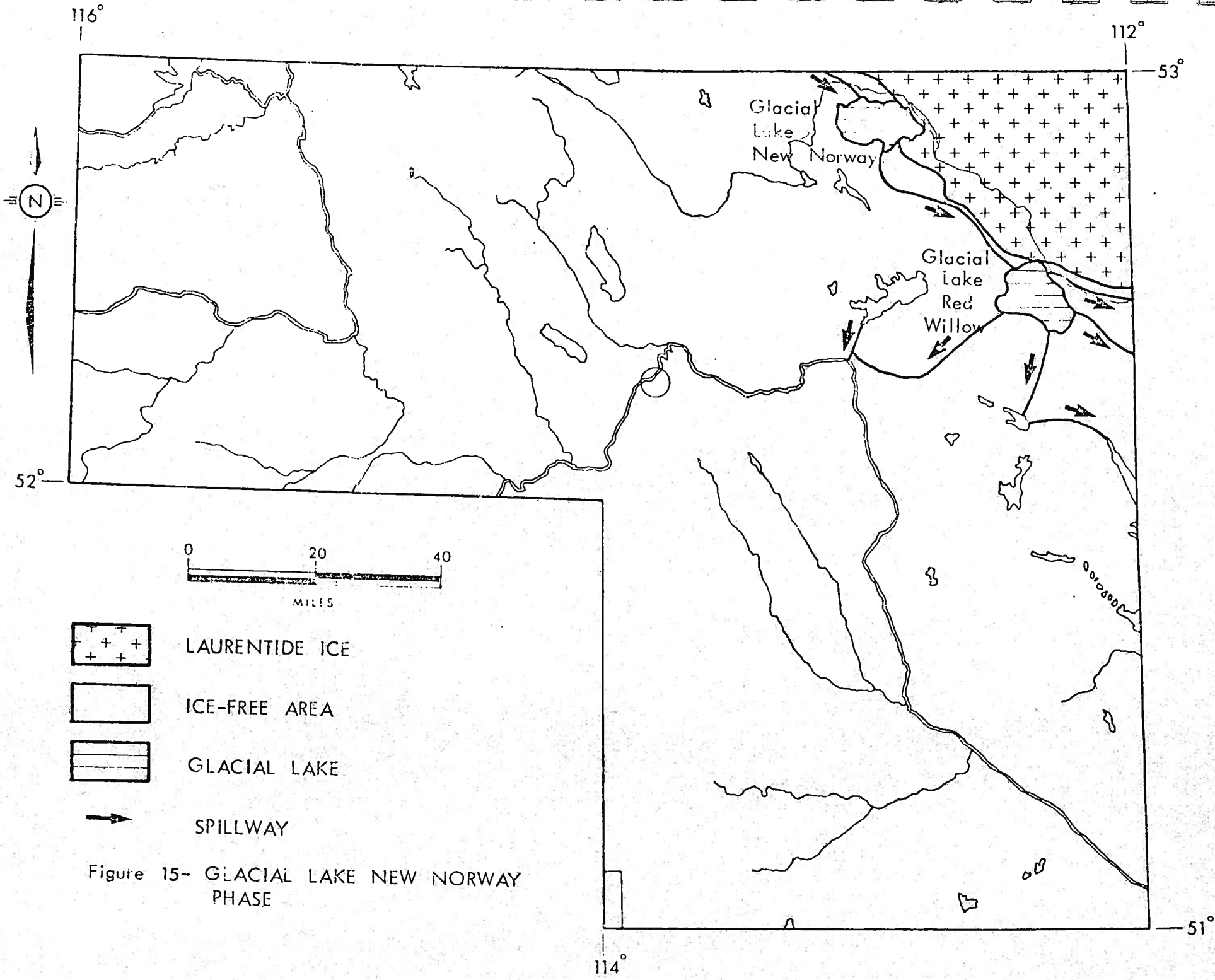

Figure 15- GLACIAL LAKE NEW NORWAY PHASE

POST-GLACIAL DEPOSITS

Distribution of major post-glacial alluvial deposits is indicated in Figure 16. Alluvium is less common in eastern parts of the area where river gradients are much lower.

Aeolian deposits mainly possess northeast orientated dune axes (Figure 17). The dunes became stabilized between 7,000 and 9,000 years ago (Taylor, 1966) although some reworking is in evidence.

DATING OF EVENTS

Very little information is available to date events of the Quaternary. Boydell estimates that deglaciation probably commenced between 13,500 and 12,500 years B.P. On the basis of radiocarbon dates on bison bone and gastropods from a site east of Rocky Mountain House, Boydell concluded that this area was probably ice-free soon after 9,600 years B.P. The bison bone (9,670 ± 140 years B.P.) and the gastropods (10,250 ± 165 years B.P.) were recovered from lake sediments enclosed in till beneath a low hummock.

Westgate et al. (1970) recognized Bridge River tephra near Nordegg. Studies to date have not related the tephra to the local stratigraphy nor has the material been dated. The proximity of the Saskatchewan River Crossing section as described by Westgate et al. would suggest that occurrences of St. Helens and Mazama tephras may also be anticipated within the study area.

Locations of some Paleo-Indian sites are shown in Figures 18, 19 and 20 (from Wormington and Forbis, 1965; Taylor, 1966). The Clovis find is not considered by Wormington and Forbis to be a confirmed identification. If the generally accepted age of 10,000 years for Clovis materials is assigned to the artifact however, this is an indication that an ice-free environment existed in the Red Deer area at that time. A number of Edon points have been found near Red Deer and, assuming an age of approximately 8,000 years B.P. for the materials, it is evident that occupation sites were established in the area by then. Scottsbluff and Alberta points are generally dated at approximately 6,000 years B.P. Several finds of these artifacts have been made to date suggesting a hospitable climate at this time. Most of the finds have been made on or near glacial lacustrine areas but much further information would be required to reconstruct physical and habitational

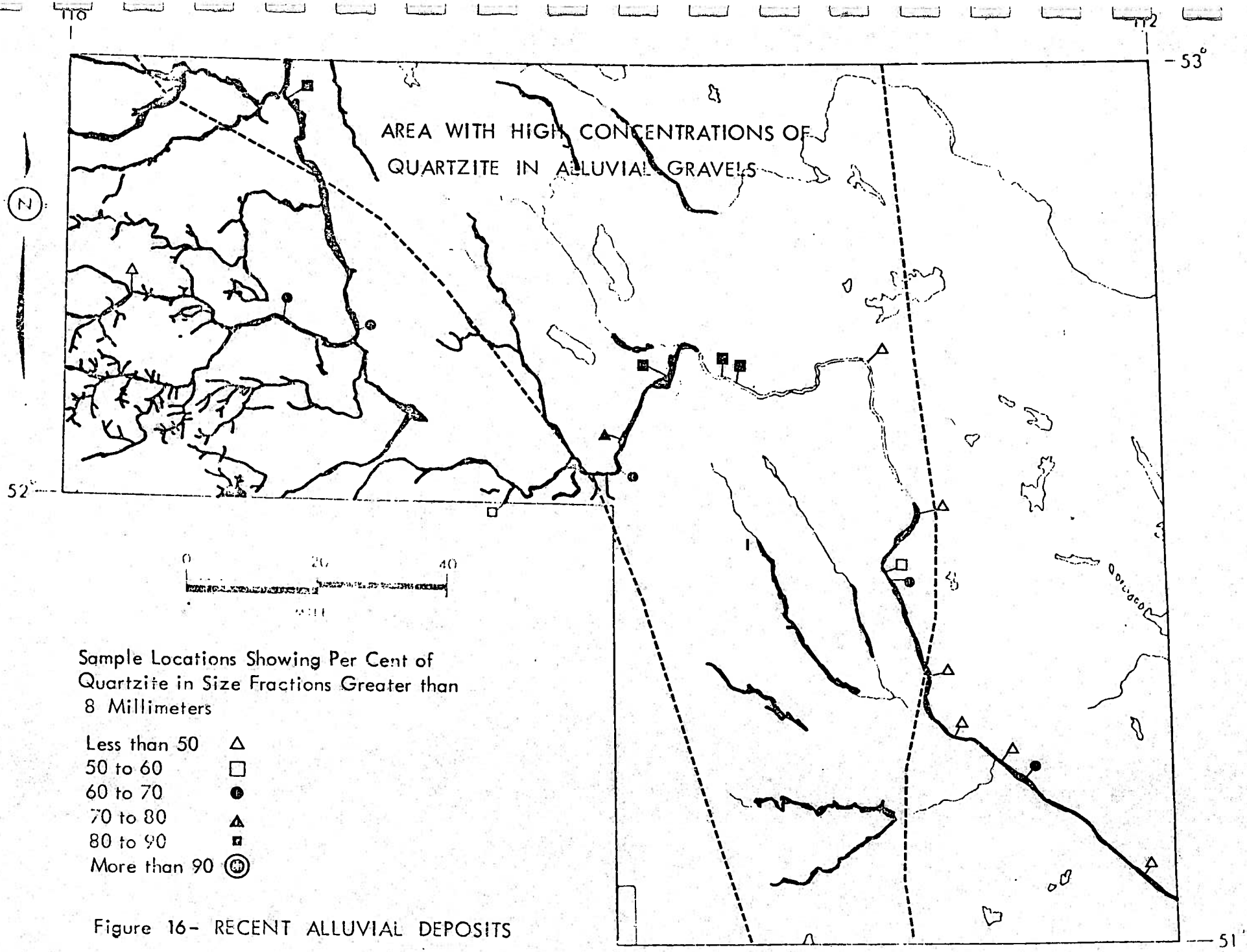

Figure 16- RECENT ALLUVIAL DEPOSITS

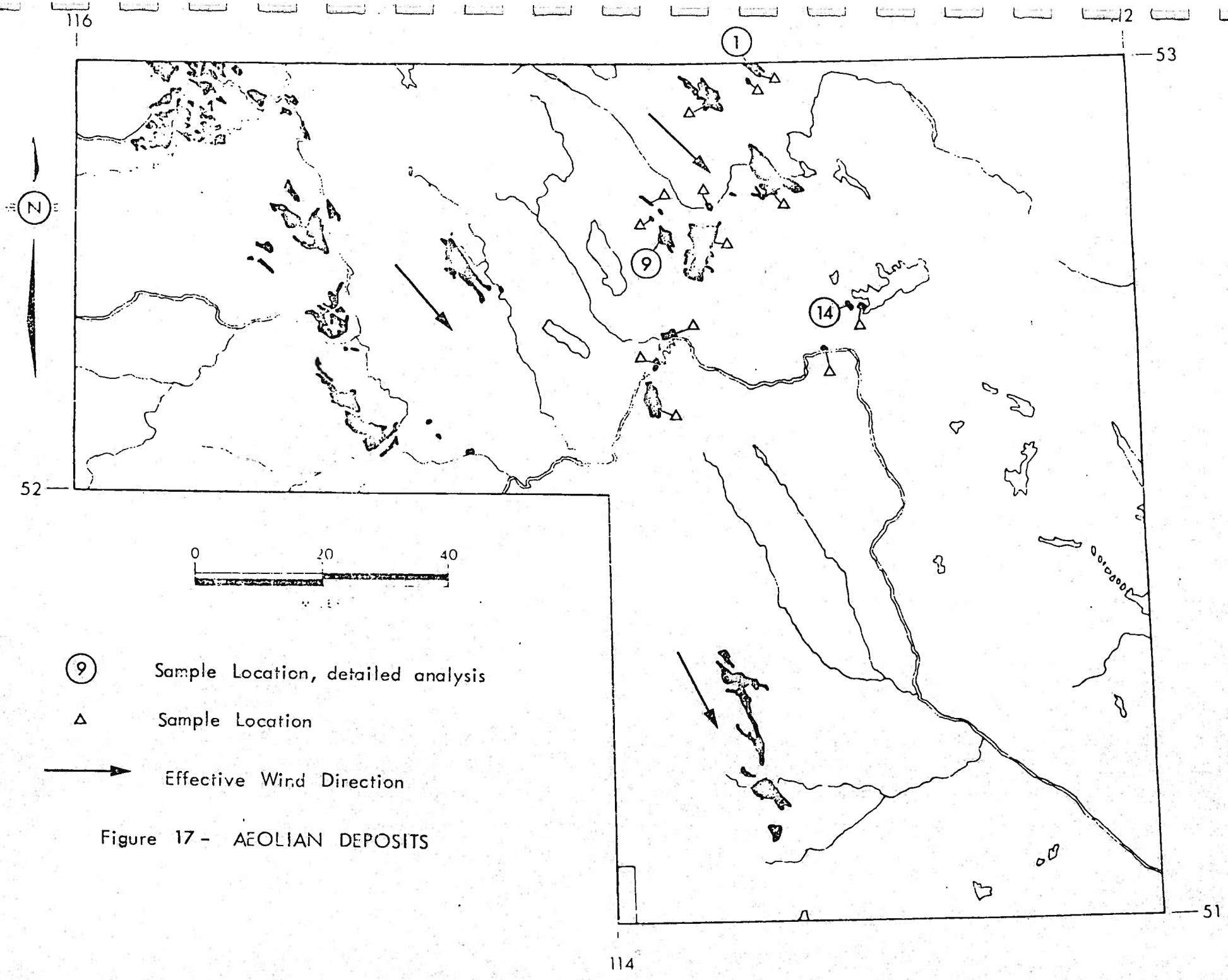

Figure 17 - AEOLIAN DEPOSITS

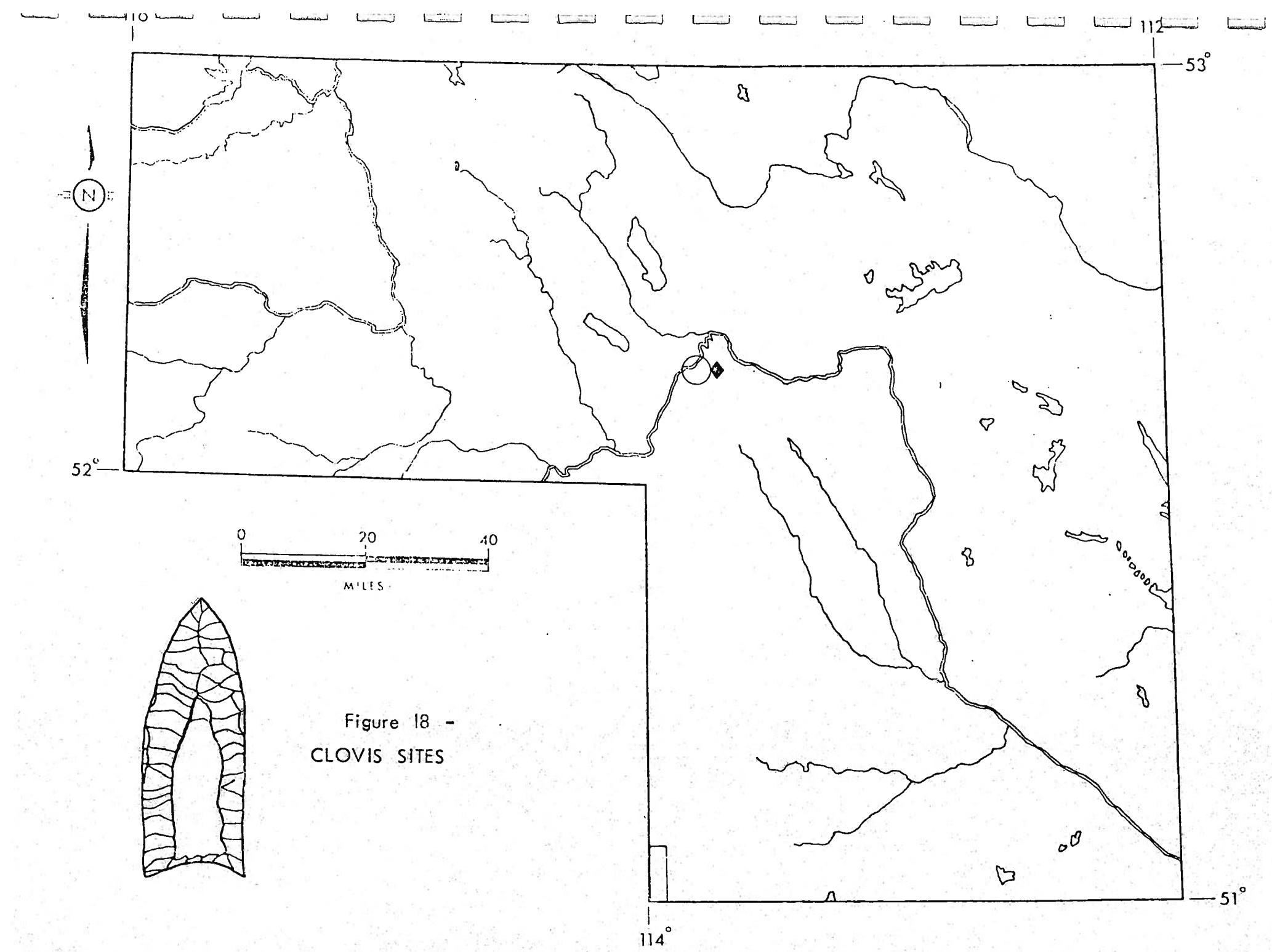

Figure 18 -
CLOVIS SITES

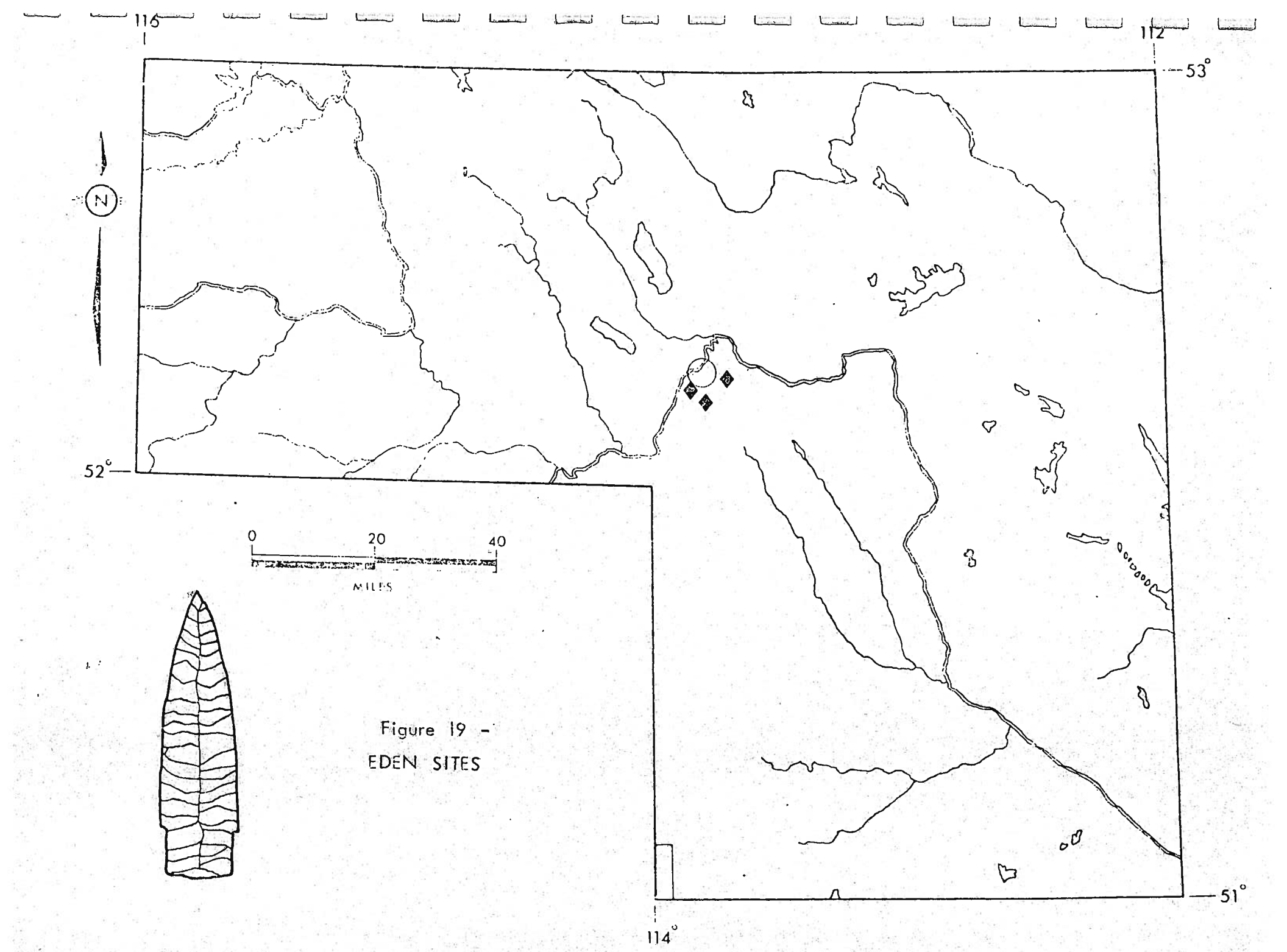

Figure 19 -
EDEN SITES

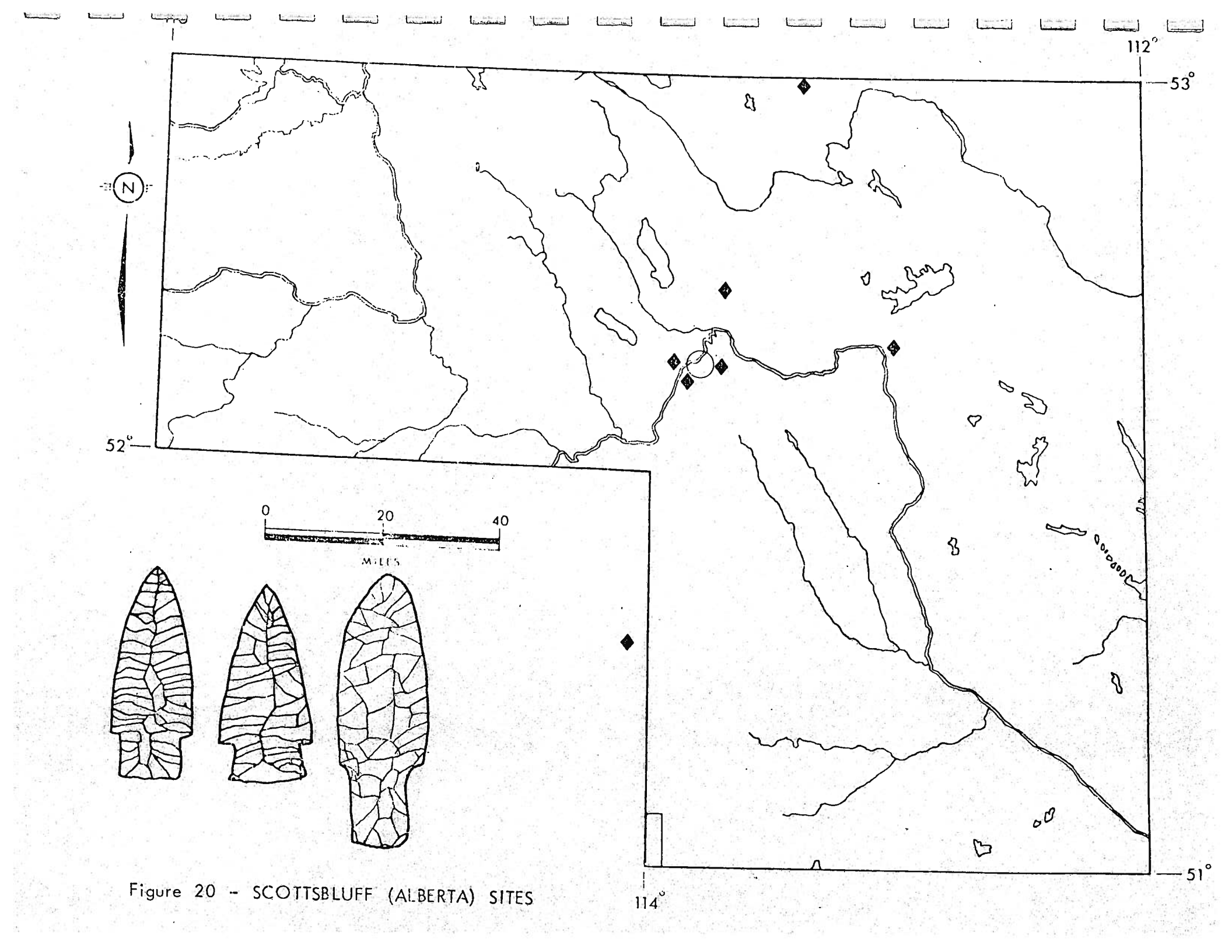

Figure 20 - SCOTTSBLUFF (ALBERTA) SITES

environments.

ECONOMIC CONSIDERATIONS

Quaternary deposits are undoubtedly of greatest economic importance as sources of sand and gravel for construction purposes. It is beyond the scope of this paper to delineate these materials other than noting that areas of deposition of alluvium and outwash deposits (including eskers and kames) are prime targets for evaluation.

Halferdahl (1969) carried out extensive studies on river gravel pebble compositions, particularly the quartzite fractions, as possible sources of materials for industrial uses such as grinding balls and high grade silica. High concentrations of quartzite were outlined within a broad belt through the central part of the area (Figure 16).

Aeolian deposits have been subjected to analyses and beneficiation studies (Holter, 1972). Localities 1, 9 and 14 in Figure 17 yield materials which are capable of upgrading to a quality comparable to sand mined in the Bruderheim area for producing fibre-glass.

An appreciation of Quaternary stratigraphy is of the utmost importance in defining groundwater sources in the area.

CONCLUSIONS

At least three major tills of Laurentide origin are evidence of three distinct periods of continental glaciation in the area, two of which are probably pre-Wisconsin. A minimum of three advances of Rocky Mountain glaciation of Wisconsin age have been recorded. A region of till cover resulting from mixed glaciation occurs between the two pre-existing ice sheets.

Deglaciation was complete in the western part of the area soon after 9,600 years B.P. Ponding of melt water upon glacial retreat led to the development of a series of glacial lakes. The resultant establishment of spillways altered regional drainage to the southeast.

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