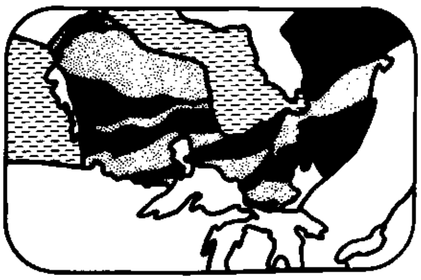

# DNAG #1. Subdivisions of the Superior Province of the Canadian Shield

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**Abstract**
Past attempts to subdivide the Canadian Shield into provinces and subprovinces have relied primarily on variations in structural trends and styles, and to a lesser degree on isotopic ages of rock units and events. In the Superior Province, subdivisions based on all, or combinations of, structural trends and styles, lithology, absolute and relative ages of rock units and events, metamorphic grade, metallogenesis, and geophysical characteristics, leads to recognition of several different types of litho-tectonic domains, including volcano-plutonic, metasedimentary, plutonic, and high-grade gneiss subprovinces. These are considered to represent the primary components assembled in the Late Archean to form the Superior Province craton. The Superior Province is thus seen to consist of northern and southern high-grade gneiss terrains, in part at least of Early Archean age, and a broad central region consisting of elongate, east-west trending volcano-plutonic and metasedimentary subprovinces.

**Condensé**
Nous proposons une révision des subdivisions de la Province litho-tectonique du Supérieur et plus particulièrement du Québec où les tentatives antérieures se sont avérées relativement pauvres. Un tel exercice fait de faĉon périodique est à notre avis absolument essentiel pour une meilleure compréhension de l'évolution des cratons en ce qu'il nous oblige à faire le bilan de nos "ignorances" et à remettre en questions nos connaissances.

**Travaux Antérieurs**
Les premières tentatives de subdivisions ont été réalisées par Wilson (1939) sur des bases plutôt géographiques (Fig. 1). D'un point de vue géologique, les premiers essais sont le fait de Gill (1949) (Fig. 2). Il y établit des relations chronologiques entre les différentes provinces du bouclier et distingue la "Province Ungava" sur des bases structurologiques. Tuzo Wilson (1949) vers la même époque, sépare le bouclier en provinces structurales et géochronologiques. La notion d'accrétion continentale est présentée (Fig. 3). Les bases des subdivisions actuelles sont jetées par Stockwell (1964, 1982), où il évoque le fait que les provinces du bouclier ont pour origine des orogénies différentes, chacune pouvant contenir des roches d'âges variés (Fig. 4). Les travaux subséquents de Douglas (1973) et Goodwin (1978), (Fig. 5), pour suivent la même idée de base mais avec des considérations lithologiques quelque peu différentes.

**Subdivision dans la Province du Supérieur**
La Province du Supérieur s'étend sur plus de 2 millions de km² et forme le centre du bouclier Canadien. Il s'agit du plus grand craton Archéen, où les âges sont généralemente supérieur à 2500 Ma; il est bordé par la Province de Churchill au nord, par la Fosse du Labrador à l'est et par le Front de Grenville au sud-est. Des roches sédimentaires plus jeune masque le sud et la partie centrale (Baie James et Baie d'Hudson) du craton (Fig. 7).

L'image du Supérieur que nous proposons est basée sur les données structurales, lithologiques, métamorphiques, isotopiques et géophysiques disponibles. Ces données sont de qualité très variable et généralement plus fiables au sud qu'au nord.

Les contacts entre les différentes subprovinces ont été placés les long des contacts lithologiques, des discontinuités structurales où des transitions d'ordre métamorphique. Nous avons ainsi reconnu quatre types de domaines litho-tectoniques: (1) volcano-plutonique; (2) métasédimentaire; (3) plutonique; (4) gneiss catazonaux. Ils diffèrent les uns des autres par le style et les tendances structurales, par le contexte lithologique, par le degré de métamorphisme, par les âges isotopiques des roches et des événements géologiques, par leurs caractéristiques magnétiques et gravifiques et par leur métallogénie.

La Province du Supérieur présente une zone centrale composée de linéaments volcano-sédimentaires, métasédimentaires et orthogneissiques épizonaux et mésozonaux, bordée au nord par des domaines orthogneissiques essentiellement catazonaux, région Ungava, (Fig. 8), et au sud par un petit domaine aux roches identiques, la sous-province de la R. Minnesota, (Fig. 7).

Du côte Ontario, notre proposition de classification ne change guére des travaux de Douglas (1973), (Fig. 5), à l'exeption de l'ajout de la sous-province plutonique de la R. Winnipeg. Du côté Québec, nous proposons un portrait relativement différent. La Fig. 7 montre deux sous-provinces volcano-plutoniques, Abitibi et R. La Grande, trois sous-provinces métasédimentaires, R. Némiscau, R. Opinaca, et Opatica, une sous-province plutonique, Bienville, et deux sous-provinces gneissiques catazonales, Minto et Ashuanipi.

Un portrait plus détaillé du Supérieur côté Québec est proposé à la Fig. 8. Il est dabord divisé en trois régions géographiques (et administratives) qui vont chevaucher les sous-provinces déjà proposées. Nous croyons que cet exercice va réconcilier les concepts géologiques et géographiques, avec les habitudes toponymiques des géologues de terrain.

La sous-province Abitibi peut être subdivisée à son tour en trois ceintures volcano-plutoniques, Abitibi (s.s.), R. Broadback et R. Eastmain. Dans l'échelle des subdivisions, des travaux récents ont été réalisés à un degré plus bas par Dimroth *et al.* (1982, 1983), Gélinas *et al.* (1984) et Hubert *et al.* (1984) et portant sur des synthèses litho-stratigraphiques et structurologiques internes de la ceinture Abitibi.

**Contextes Geologiques**
L'étendue vers l'est de la sous-province métasédimentaire Opatica n'est pas vraiment connu, et bien que de morphologie incertaine, elle constitue la suite de la sous-province Quetico décrochée par l'accident de socle de Kapuskasing et est bordée au nord-est par un autre grand accident de socle, orienté nord-ouest, et trés visible sur les cartes aéromagnétiques.

Les deux sous-provinces métasédimentaires qui suivent, R. Nemiscau et R. Opinaca, ont été cartographiées dans les années 70 par les géologues provinciaux du Québec. Sauf pour la partie est de la sous-province de la R. Opinaca leur morpholgie n'est pas spéculation et correspond probablement à la terminaison, déformée de façon polyphasée, de la sous-province English River. Notons que nous avons incorporé dans les sous-provinces métasédimentaires des roches d'origine anatectique contenant des enclaves de paléosome.

La limite nord de la sous-province volcano-plutonique de la R. La Grande est marquée par des grandes failles où accidents de socle déduits d'après les structures apparentes sur les cartes aéromagnétiques. Notons qu'elles ne sont pas visibles sur le terrain. Des masses tardi-tectoniques de composition granodioritique bordent ces failles. Elles ont été distinguées des gneiss tonalitiques associés aux roches volcaniques et des orthogneiss de socle, mais ne sont par tramées sur la Fig. 8.

La région Ungava, comprend trois sous-provinces. Au sud, celle du Bienville est essentiellement plutonique et comprend des gneiss granitiques à multiples enclaves d'amphibolites. Elle contient dans sa portion sud-ouest, une zone plus intensément tectonisée exhibant des roches du faciès granulite. Sa limite sud a été établie d'après les cartes aéromagnétiques et est plus où moins arbitraire puisqu'il n'existe par sur le terrain de distinction lithologique marquée entre la sous-province de la R. La Grande et celle du Bienville.

Le pourtour de la deuxième sous-province, du nom d'Ashuanipi, a aussi été établi d'après les cartes aéromagnétiques. Mais dans ce cas, les roches du faciès granulite abondent et les distinctions lithologiques sont suffisamment marquées sur le terrain pour justifier sa présence. Il reste toutefois que la zone entre la sous-province Ashuanipi et celle de la R. Opinaca et de la R. La Grande est pratiquement inconnue.

Au nord, la sous-province du Minto, est plus complexe et contient des roches du faciès granulite, des roches gneissiques apparentées à celles de la sous-province du Bienville, des roches métasédimentaires et des granitoids tardi-tectoniques. Les tendances structurales sont nord-nord-ouest et nord avec un axe central à foliations plus où moins horizontales. Elles contrastent avec les tendances structurales de la sous-province du Bienville qui sont essentiellement est-ouest. Leurs âges relatifs sont mal connus comme pour le reste de la région Ungava.

### Introduction

Periodic attempts have been made to subdivide the vast Precambrian Shield of Canada into genetically meaningful geological units. In addition to facilitating portrayal and description of the complex geology, such exercises force critical examination of what we know, or think we know, emphasize what we do not know, and may lead to better understanding of the origin and evolution of the ancient craton.

In this paper we examine several of the subdivisions proposed by earlier workers, followed by presentation of our own ideas concerning subdivision of the Superior Province. It is hoped that this will promote discussion. No subdivision can be permanent; as new data appear, and basic concepts evolve, so too will ideas about meaningful geological subdivisions.

### Historical Sketch of Canadian Shield Subdivision

M.E. Wilson (1939) made one of the first attempts to subdivide the Canadian Shield into a number of geological-geographical provinces and subprovinces (Fig. 1). Although Wilson's subdivisions were based in large part on geography, they nevertheless focussed attention on the fact that the Shield comprises several geologically distinctive domains.

J.E. Gill (1949) outlined geological provinces based primarily on structural trends (Fig. 2). He further divided these structural provinces into subprovinces on the basis of "features superimposed on the primary and dominant trends by later sedimentation and structural disturbances". These subprovinces he termed "mountains", "plains" and "belted plains" in reference to their inferred structural, rather than geomorphic, character. Gill recognized that changes in structural trend from one province to another indicated a time sequence. He concluded that the Churchill Province structures were younger than Slave Province structures and older than Superior Province structures, and that the Grenville Province structures were younger still. Gill also distinguished an "Ungava Province" on the basis of northerly-trending structures in northern Quebec that extend south to the Eastmain River where they give way to the east-west structures of the Superior Province.

At about the same time, J. Tuzo Wilson (1949) subdivided the Shield into provinces based not only on structural trends but also on lithological and isotopic age characteristics. The pattern of decreasing ages of orogenic belts away from a central Superior Province nucleus was taken by Wilson as evidence for growth of the continent by successive accretion of marginal orogenic belts (Fig. 3).

C.H. Stockwell's (1964, 1982) division of the Shield into provinces and subprovinces (Fig. 4) was based fundamentally on differences in overall structural trends and style of folding. Province and subprovince boundaries were placed along structural fronts where older structures are truncated by younger, along major regional unconformities, and at changes in degree of regional metamorphism. Stockwell emphasized that the subdivisions were not based on lithology or age as each domain contained a variety of rock types of various ages. Stockwell considered that different structural trends were produced by different orogenies and hence that the provinces correspond closely to orogenic divisions. He used histograms of isotopic ages, mainly K-Ar, to determine the times of these orogenies and utilized the limits of their effects as one of the criteria to establish province and subprovince boundaries.

R.J.W. Douglas (1973) generally followed Stockwell's method of subdivision according to dominant structural trends, but apparently did not place much reliance on K-Ar dates as evidence for significant structural overprinting. It is also apparent from the names given to many subprovinces (Fig. 5) that he recognized that many belts had a characteristic lithology. The most noteworthy departure of Douglas' subdivision of the Superior Province from that of Stockwell is in the northwest. Here, Stockwell recognized a "Cross Lake belt" consisting of Archean rocks that he considered to be reworked during Proterozoic (Hudsonian) orogenic events, mainly on the basis of a few K-Ar dates younger than the prevailing Archean dates of the rest of the Superior Province. Douglas,

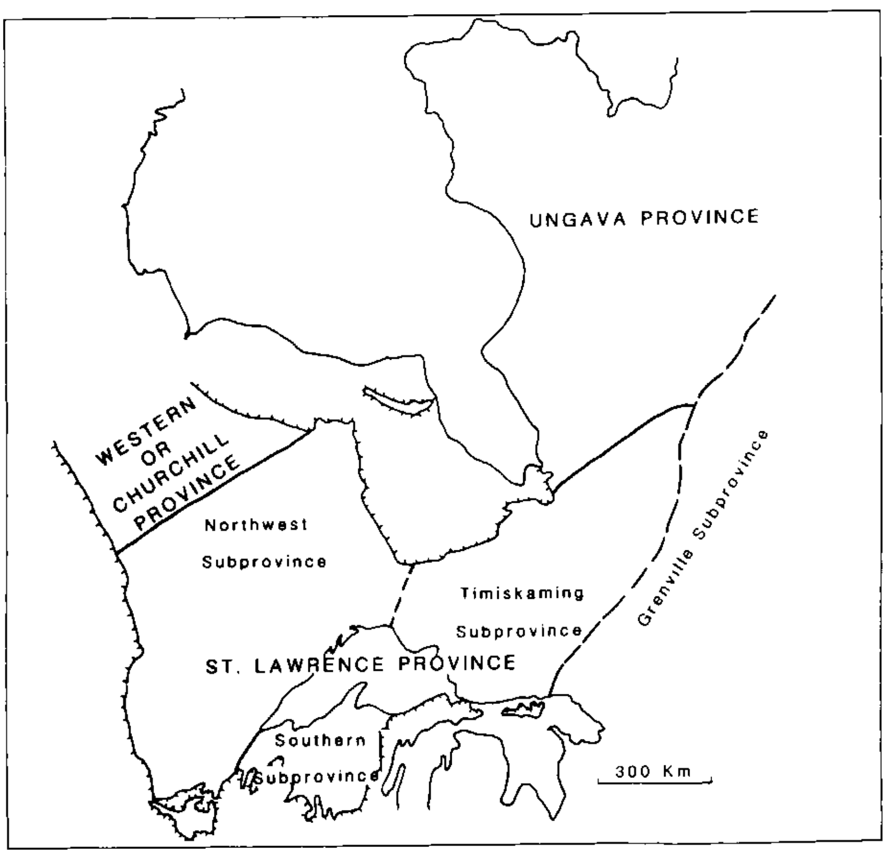


**Figure 1** *Subdivisions of the Canadian Shield by M.E. Wilson (1939).*

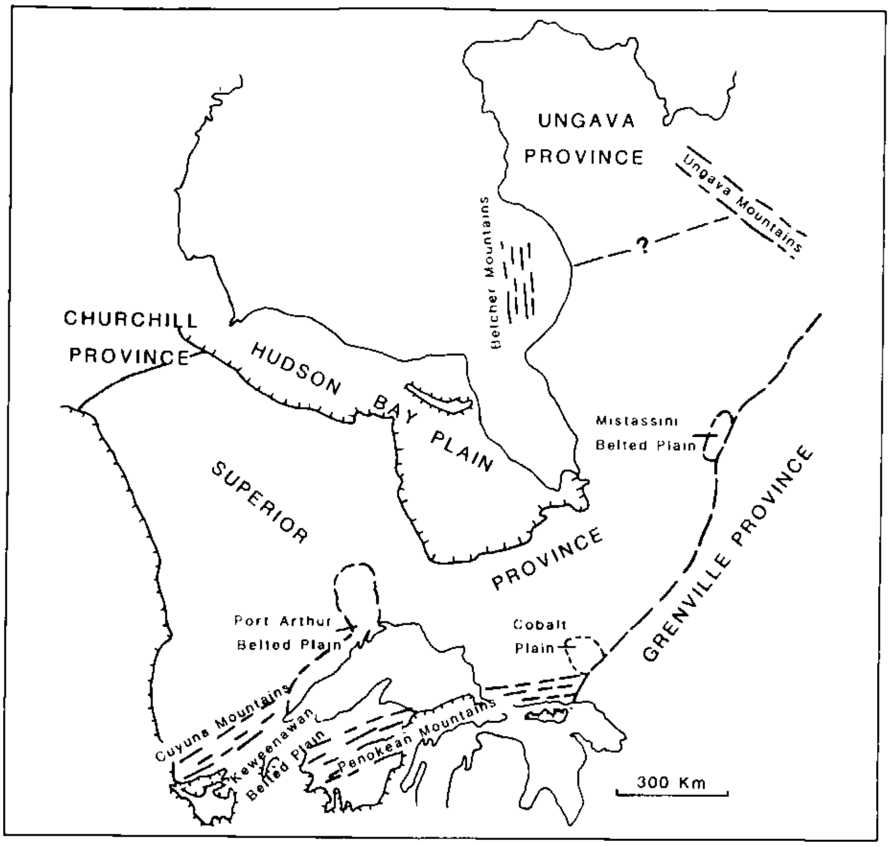


**Figure 2** *Subdivisions of the southern Canadian Shield by J.E. Gill (1949).*

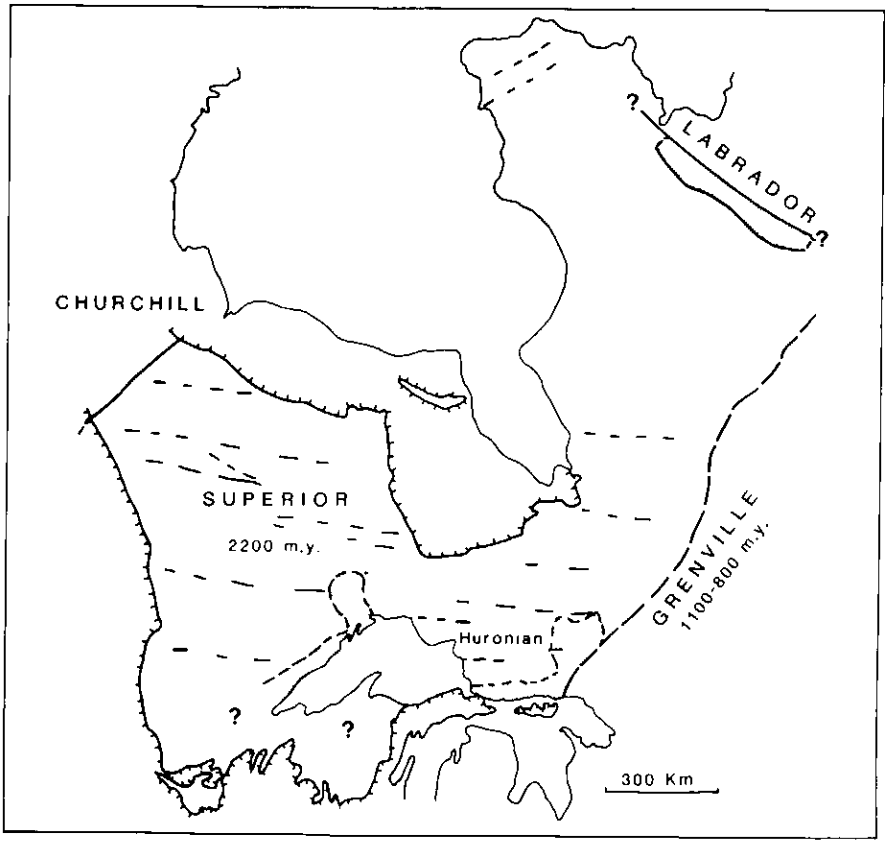


**Figure 3** *Subdivisions of the southern Canadian Shield by J. Tuzo Wilson (1949).*

who apparently did not place much weight on these young K-Ar dates, arrived at the different interpretation shown in Figure 5.

More recently, lithological differences from one part of the Superior Province to another have been emphasized and utilized in establishing subprovinces. A.M. Goodwin (1978) noted that in northwestern Ontario the system of alternating volcanic-plutonic belts and metasedimentary gneiss belts provides a basis for regional tectonic subdivision into subprovinces or "superbelts". On the geological map of Manitoba (Manitoba Mineral Resources Division, 1979) lithostructural subdivisions of Superior and Churchill Provinces are based on all, or combinations of, structural trends, ages of orogenic events, lithology, metamorphic grade, and geophysical characteristics. Several lithologically and tectonically distinctive types of domains are recognized, including metasedimentary gneiss, granite-greenstone, granulite, batholithic granite-gneiss, and structural zones.

It is this holistic approach, with consideration and integration of all available geological and geophysical data that is favoured by the authors. It is in this way only that genetically meaningful subdivisions can be established so that the primary crustal building blocks, their inter-relationships and evolution, may be recognized.

## Geology and Subdivisions of the Superior Province

The Superior Province, exposed over an area of more than 2 million km², is the world's largest relatively undisturbed Archean craton. It is considered to include most of the Archean (>2500 Ma) rocks of the Canadian Shield about James Bay and southern Hudson Bay (Fig. 6). Parts of it are buried beneath Phanerozoic strata of the Interior Plains and the Michigan, Hudson, and Moose River Basins, and beneath little-deformed Proterozoic cover sequences such as those of the Cobalt Embayment and the Mistassini Homocline. The Superior Province is surrounded by Proterozoic orogenic belts: the Grenville Province on the southeast, the Churchill Province on the east, north and west, and the Southern Province on the south. The Superior-Grenville contact, the Grenville Front Tectonic Zone, is a broad zone of Middle Proterozoic faulting and dislocation that includes rocks of both Archean and Proterozoic ages. The Superior-Churchill boundary is in part tectonic and in part an unconformity of Early Proterozoic age. The Superior-Southern boundary is, for the most part, an Early Proterozoic unconformity.

There are Archean rocks within the surrounding Proterozoic orogens but they have been generally reworked tectonically and isotopically and are here considered parts of these Proterozoic orogens. The problems of defining geological province boundaries are well illustrated by the Superior-Churchill boundary in Manitoba (see Bell, 1971, for discussion). This boundary is actually a broad zone of faulting bounded on the southeast by Archean high-grade gneiss of the Pikwitonei Subprovince and on the northwest by Proterozoic supracrustal rocks. The boundary zone itself, the Thompson Belt, consists of variably reworked Archean gneiss and Proterozoic supracrustal rocks. In this paper we have followed Douglas (1973) in assigning the Pikwitonei Subprovince to the Superior Province and the Thompson Belt to the Churchill Province.

The definition and characterization of the boundaries between subprovinces of the Superior Province are also major problems. Subprovince boundaries are in many cases zones of structural and metamorphic transition of appreciable width in which faulting, cataclasis, and igneous activity may have masked any primary lithological transitions. Nevertheless, an understanding of the primary nature of the boundaries between different terranes is of fundamental importance for development of models of crustal evolution.

In many places, subprovince boundaries may be placed along faults, notably along faults of a major east-west dextral transcurrent system that extends throughout much of the Superior Province (Fig. 7). Examples include the Sydney Lake Fault, which forms part of the Uchi-English River boundary, the Quetico and Seine River Faults, which form part of the Quetico-Wabigoon boundary, the Cadillac Fault forming the Abitibi-Pontiac boundary, and the La Grande River Fault, forming the Bienville-La Grande boundary. Across these fault zones, which in cases are a kilometre or more wide, there may be juxtaposition of contrasting lithological sequences, of low-grade and high-grade metamorphic rocks, and of contrasting structural styles and trends. There are also sequences of late alluvial-fluvial sediments and alkalic or shoshonitic volcanics associated with some subprovince boundary faults. Examples would include the Timiskaming Group along the Cadillac Fault in the Kirkland Lake-Rouyn area and the Seine Conglomerate associated with the Quetico and Seine River Faults in the Rainy Lake area. Such deposits may represent the fill of pull-apart basins formed by movements along the fault zones. The amount of strike-slip displacement on these faults is unknown, and furthermore the late transcurrent movements may in some cases mask earlier convergent thrusting and folding.

In areas where subprovince boundaries are not faulted, they are seen as zones of lithological, metamorphic, or structural transition. Poulsen (1980) described the Wabigoon-Quetico boundary in the Fort Frances area as a zone of structural and metamorphic complexity with polyphase folding, overturned supracrustal sequences, and downward-facing structures between dominantly volcano-plutonic rocks in the north and metasedimentary rocks in the south. Mackasey

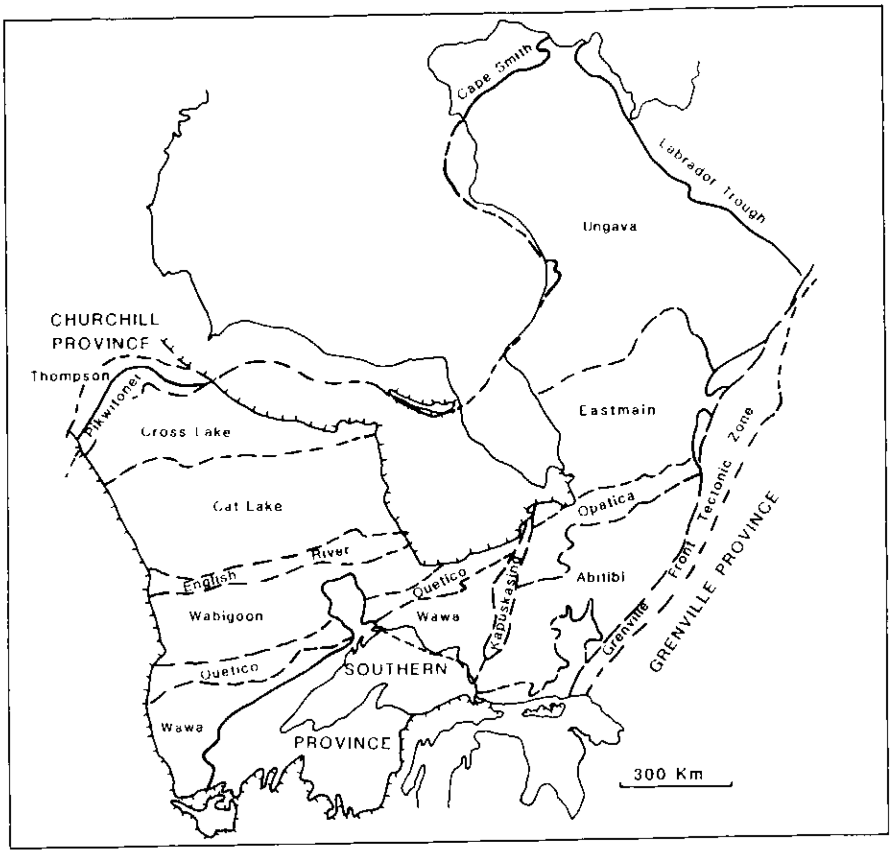


**Figure 4** *Subdivisions of the southern Canadian Shield by C.H. Stockwell (1982).*

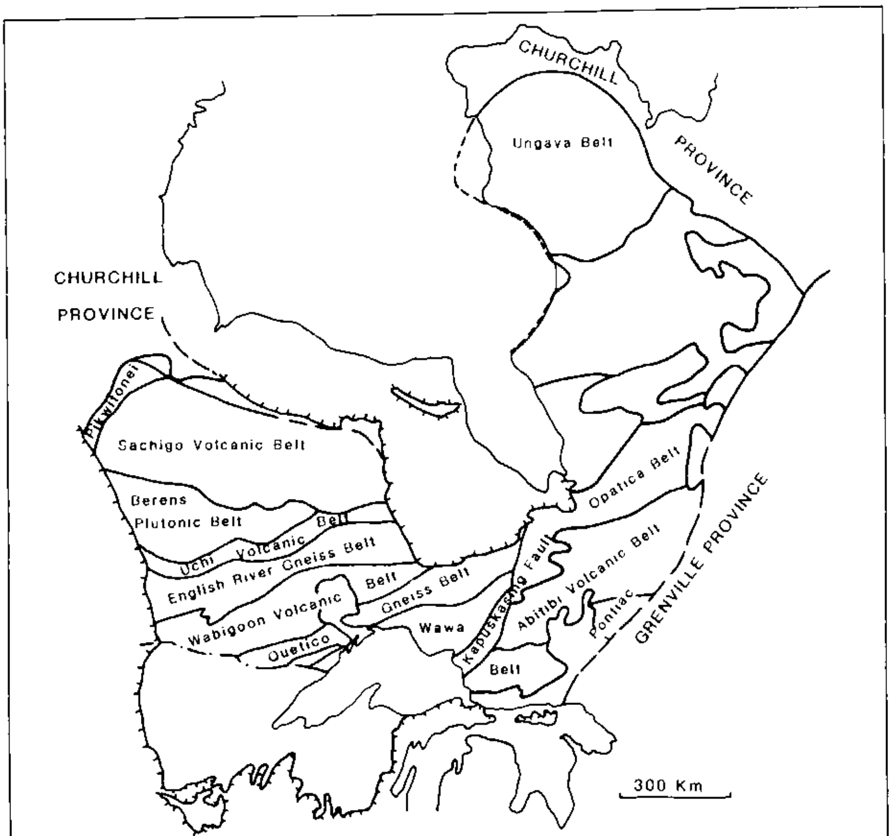


**Figure 5** *Subdivisions of the southern Canadian Shield by R.J.W. Douglas (1973).*

*et al.* (1974) concluded that the Quetico-Wabigoon boundary in the Geraldton-Beardmore area is a zone of transition from a dominantly volcanic sequence in the north to a dominantly sedimentary sequence in the south. Kehlenbeck (1975) described the Quetico-Wabigoon boundary north of Thunder Bay as a zone of transition with a complex history of polymetamorphism in which metamorphic isograds are parallel to the subprovince boundaries as defined on structural and lithologic criteria.

Along much of the Wabigoon-Winnipeg River Subprovince boundary, tonalitic gneiss to the north is juxtaposed with metavolcanics and metasediments to the south. Some of the Winnipeg River gneiss units have ages of about 3000 Ma (Krogh *et al.*, 1976) whereas the metavolcanics are about 2700 Ma. This led Clark *et al.* (1981) to postulate an unconformable relationship between the two sequences. If such an unconformity did exist, it has been effectively obliterated by subsequent faulting and cataclasis.

Interpretation of geophysical data over parts of the Superior Province (for example Hall and Brisbin (1982), Gupta and Barlow (1984) and others) suggests that plutons and greenstone belts of the Wabigoon and Uchi Subprovinces generally extend to depths of only 5 to 10 km. In the English River Subprovince, dense high-grade metasediments occupy a trough that extends to depths of about 10 km, producing a pronounced positive gravity anomaly. The Winnipeg River Subprovince is characterized by relatively highly magnetic plutons that extend to depths of about 20 km. There are abrupt changes in depth to the Conrad Discontinuity and to the Moho from one subprovince to another, indicating significant structural relief across subprovince boundaries.

The provisional subdivisions of the Superior Province presented in Figure 6 are based on consideration of available geological, geochronological, and geophysical data. Availability and quality of data are varied, but, with the exception of heavily drift-covered areas south of James Bay and in Minnesota, are generally better in the south than in the north. Insofar as possible, on 1:5 million scale compilation maps, subprovince boundaries are placed at lithologic contacts, structural discontinuities such as faults, and at metamorphic transitions. Four types of litho-tectonic domains are recognized: (1) volcano-plutonic; (2) metasedimentary; (3) plutonic; and (4) high-grade gneiss. These domains differ from one another in all or some of the following: (a) structural trend and style; (b) lithologic makeup; (c) metamorphic grade; (d) isotopic ages of rock units and events; (e) geophysical attributes, chiefly their aeromagnetic and gravity characteristics; and (f) metallogenic characteristics. It is the recognition of these domains and their distinctive characteristics that provides the basis for subdivision of the Superior Province into subprovinces. It should be noted that of the recognized types of lithotectonic domains, the volcano-plutonic and metasedimentary subprovinces are closely associated spatially, and probably genetically, possibly representing accreted volcanic arc and associated sedimentary terranes. Alternating volcanic-rich and sediment-rich domains form the prominent striped pattern of central Superior Province and they are bounded in part on the north and south by high-grade gneiss domains.

### Volcano-Plutonic Subprovinces

Volcano-plutonic subprovinces such as the Abitibi, Uchi, and Wabigoon are characterized by dominantly metavolcanic supracrustal sequences, the greenstone belts, and are bordered and intruded by voluminous felsic

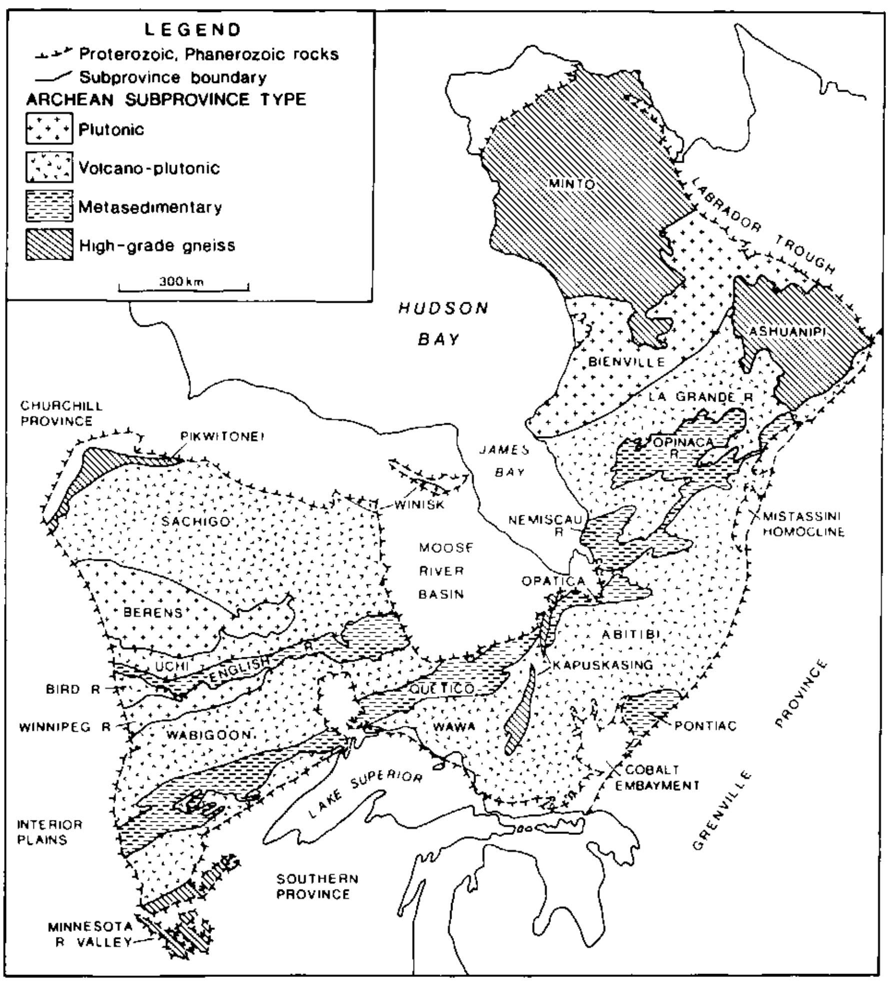


**Figure 6** *Proposed subdivisions of the Superior Province.*

plutonic rocks, including early synvolcanic plutons and tonalitic gneiss, and younger foliated to massive plutons ranging from quartz diorite to granite and syenite. The structural patterns of the volcano-plutonic subprovinces are typically irregular, the product of polyphase deformation that formed sinuous, bifurcating, commonly synformal metavolcanic belts with upright folds and steep lineations, and intervening, commonly domal, gneissic-plutonic domains. Metamorphic grade in the metavolcanic belts is generally subgreenschist or greenschist in the central parts and increases outward to low-pressure amphibolite facies in the margins and in the surrounding plutonic gneisses. The volcano-plutonic subprovinces constitute the most economically important parts of the Superior Province, with major deposits of gold, copper, zinc and iron, associated mainly with the greenstone belts.

In the Abitibi, Wawa and Wabigoon Subprovinces, major volcanism, deformation, metamorphism and plutonism occurred mainly between 2750 Ma and 2650 Ma ago, as determined by U-Pb zircon ages (for example, see Krogh and Turek, 1982). There is some evidence for older (ca. 2900 Ma) plutonic rocks in the Wawa Subprovince (Turek *et al.*, 1984). In the Uchi and Sachigo Subprovinces, there was volcanism and plutonism in the range 3000 to 2800 Ma and again between 2750 and 2700 Ma (for example, see Nunes and Thurston, 1980).

### Metasedimentary Subprovinces

Metasedimentary subprovinces such as the Quetico and Pontiac are characterized by dominantly sedimentary supracrustal rocks, mainly turbiditic wacke and pelite, metamorphosed to schist, paragneiss, and migmatite. Most metasedimentary belts display a distinctive pattern of metamorphism with marginal low-grade (greenschist facies) metamorphism, increasing inward to low-pressure amphibolite, and locally, granulite facies. The English River and Quetico Subprovinces have a linear structural character, the product of isoclinal folding and strike-slip faulting. These structures are superimposed on earlier complex structures which may be best preserved in the more irregular Pontiac and Opatica Subprovinces. Intrusive rocks include abundant granites and pegmatites with the chemical (peraluminous) and mineralogical (biotite, muscovite, garnet, sillimanite, variably assimilated metasedimentary xenoliths) attributes of S-type granites generated by anatexis of sedimentary rocks. Deposits of tantalum, lithium and beryllium are associated with some of these intrusions. Other granitic and syenitic intrusions in the metasedimentary belts do not have S-type characteristics and were probably derived from deeper levels in the crust. The ages of rock units and events in the metasedimentary belts, both absolute and relative to the adjacent volcano-plutonic belts, are essentially unknown. The lack of precise isotopic age data in the metasedimentary belts represents one of the greatest gaps in our knowledge of Superior Province geology.

### Plutonic Subprovinces

Plutonic subprovinces such as the Berens River domain are distinguished by the near absence of supracrustal rocks. The abundant plutonic rocks include tonalitic gneiss, commonly with mafic enclaves of both extrusive (metavolcanic) and intrusive (dyke) origin, and more massive felsic plutons belonging to an older sodic suite and a younger potassic suite (Breaks *et al.*, 1978; Ermanovics *et al.*, 1979; Beakhouse, 1983). A few U-Pb zircon ages of felsic plutons in the Berens River Subprovince range from 2700 to 2900 Ma (Ermanovics and Wanless, 1983) and on felsic plutons and gneiss from the Winnipeg River Subprovince from 2600 to 3000 Ma (Krogh *et al.*, 1976). The plutonic subprovinces therefore contain some plutonic rocks distinctly older than 2700 Ma volcanic sequences in adjacent volcano-plutonic subprovinces. Whether these older plutonic domains constitute the basement upon which the younger volcanic sequences were deposited remains an open question.

Two plutonic subprovinces are proposed, Winnipeg River in western Ontario and Manitoba (as previously proposed by Beakhouse (1983)), and the Winisk plutonic domain near James Bay in Ontario (Fig. 6). The Winnipeg River Subprovince was formerly considered part of the "English River gneiss belt" (Douglas, 1973), but with recent mapping by Breaks *et al.* (1978), Beakhouse (1983) and others, it is possible to subdivide this region into a northern metasedimentary subprovince (English River), a west-central volcano-plutonic subprovince (Bird River), and a southern, Winnipeg River plutonic subprovince. Much of the tentatively proposed Winisk Subprovince is covered by Phanerozoic strata but there are exposures of foliated and massive, commonly pyroxene-bearing felsic plutonic rocks along Winisk River and in Sutton Inlier (Riley, 1979). The aeromagnetic characteristics of this subprovince also suggest that it is lithologically similar to the Berens River and possibly to dominantly plutonic subprovinces to the east in Quebec. Aeromagnetic maps (GSC, undated) indicate that the Winisk-Sachigo boundary is the northwest-trending Winisk River Fault.

### High-grade Gneiss Subprovinces

High-grade gneiss domains such as the Pikwitonei and Kapuskasing Subprovinces have intermediate- to high-pressure upper amphibolite and granulite facies gneiss of plu-

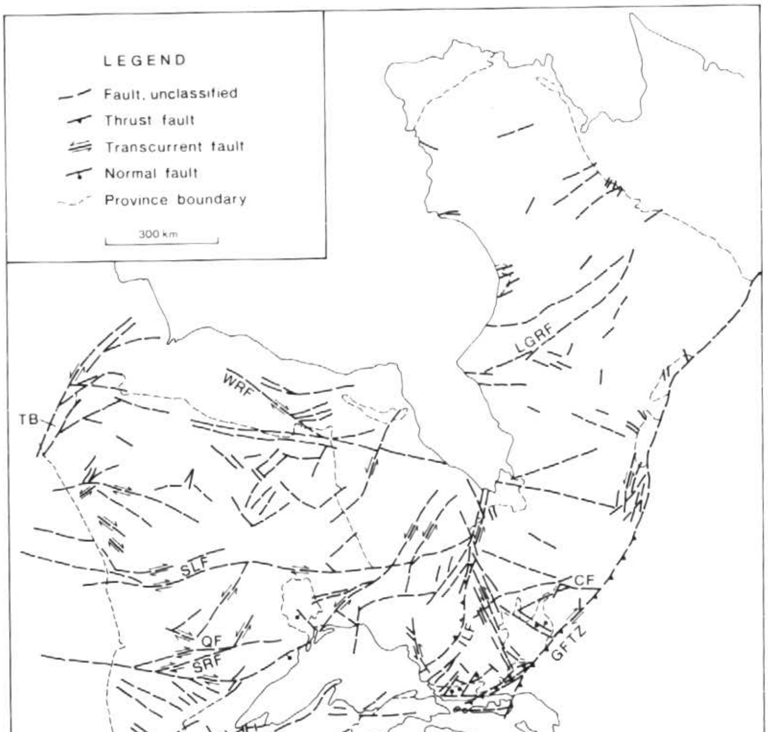


**Figure 7** *Major faults in the southern Canadian Shield. CF - Cadillac Fault; GFTZ - Grenville Front Tectonic Zone; GLTZ - Great Lakes Tectonic Zone; ILF - Ivanhoe Lake Fault; LGRF - La Grande River Fault; QF - Quetico Fault; SLF - Sydney Lake Fault; SRF - Seine River Fault; TB - Thompson Belt; WRF - Winisk River Fault.*

tonic and supracrustal origin, commonly with layered gabbro-anorthosite bodies and tonalitic, granodioritic, and syenitic intrusions, many of which are foliated and pyroxene-bearing. High-grade gneiss domains typically display domal structural patterns with variably dipping gneissosity and evidence of high strain and polyphase deformation. They have high amplitude, "birds-eye" aeromagnetic patterns, in contrast to the lower intensity, linear or curvilinear magnetic patterns of the volcano-plutonic and metasedimentary subprovinces. The Pikwitonei, Kapuskasing and Minto gneiss domains display positive gravity anomalies, presumably a consequence of the high average density of the crust in these regions. Ashuanipi Subprovince does not have a positive gravity expression, possibly indicating that the high-grade rocks here are a relatively thin veneer or are of lower density.

The Kapuskasing Structural Zone (KSZ) is a narrow, northeast-trending belt of high-grade gneiss that transects the east-west trending Abitibi-Wawa volcano-plutonic and Quetico-Opatica metasedimentary subprovinces. Rocks of the KSZ, including paragneiss, mafic gneiss, tonalitic gneiss, and the Shawmere anorthosite complex, have been deformed and metamorphosed under upper amphibolite to granulite facies conditions (Percival, 1983). The eastern contact of the high-grade KSZ with the low-grade Abitibi Subprovince is a fault, whereas westward there is a complex gradation from high-grade gneiss of the KSZ to low-grade rocks of the Michipicoten greenstone belt of Wawa Subprovince. This 120 km-wide transition zone is considered to represent an oblique section through some 20 km of Archean crust, uplifted along a major northwest-dipping thrust fault (Percival and Card, 1983; Cook, 1985).

In the southern part of the Kapuskasing Subprovince, tonalite of the Shawmere anorthosite complex has a minimum U-Pb zircon age of 2765 Ma (Percival and Krogh, 1983). Granulite facies mafic gneiss and paragneiss intruded by this complex are thus older than 2765 Ma, and are therefore older than the supracrustal sequences dated in the adjacent Abitibi and Wawa Subprovinces. Conversely, metamorphic zircons from the high-grade gneiss yield ages of 2650 and 2627 Ma, significantly younger than the 2700 to 2680 Ma age of metamorphism and deformation in the adjacent volcano-plutonic subprovinces. The Kapuskasing high-grade gneiss domain consequently has older Archean rocks, possibly as old as 3000 Ma, that were metamorphosed or uplifted from lower crustal levels in the Late Archean or Early Proterozoic (Percival and Card, 1983).

It is debatable whether the Minnesota River Valley high-grade gneiss domain should be considered part of the Superior Province, part of the Southern Province, or a distinct entity. Geological and age relationships are complex; isotopic studies, mainly by Goldich and co-workers (for example, see Goldich *et al.*, 1970) indicate that the oldest rocks are in excess of 3500 Ma but have been affected by several plutonic and metamorphic events in the later Archean and Proterozoic. The boundary between the Minnesota River Valley high-grade gneiss domain and the Late Archean volcano-plutonic subprovinces to the north is a broad zone of faulting and dislocation, the Great Lakes Tectonic Zone (Sims *et al.*, 1980). A recent COCORP seismic-reflection survey across this zone shows numerous reflection events dipping northward about 30°. These are interpreted as thrusts that may have originated during Late Archean collision between Superior Province volcano-plutonic crust and older Archean gneissic crust of the Minnesota River Valley to the south (Gibb *et al.*, 1984).

## Geology and Proposed Subdivisions of the Superior Province of Northern Quebec

Although most workers have recognized one or more geological subdivisions of the Superior Province in northern Quebec, the geological data base is insufficient to make more than a tentative interpretation. Recent 1:250,000 scale compilations and the new Geological Map of Quebec by Avramtchev (1982, 1983) and Avramtchev and Marcoux (1979) provide basic geological information on the region but do not attempt to make tectonic subdivisions. The foregoing maps, recent work by A. Ciesielski in the Bienville domain and new total field and shaded relief aeromagnetic maps (GSC, undated) used in conjunction with the reconnaissance mapping by Stevenson (1968), Eade (1966) and Taylor (1982), and the regional metamorphic study by Herd (1978) make it possible to attempt more detailed litho-tectonic subdivision. It must be emphasized, however, that the subdivisions shown in Figure 6 are tentative and that further work, especially isotopic age determinations coupled with more detailed mapping of selected areas, will undoubtedly result in modifications.

The Superior Province north of the Abitibi Subprovince can be subdivided into the James Bay region in the south and west, consisting of alternating, east-west trending metavolcanic-rich and metasediment-rich domains, and the Ungava region in the north and east, characterized by high-grade gneisses (Fig. 8). The contact between the two regions lies in part along a prominent magnetic discontinuity that roughly coincides with major faults, changes in structural trends, and lithological and metamorphic contrasts. The James Bay region represents the eastward continuation of the "striped" supracrustal-rich terrain of the western Superior Province. The high-grade gneisses of the Ungava region are similar in many ways to the rocks of the Minnesota River Valley and Pikwitonei Subprovince.

The James Bay region contains the narrow, discontinuous metavolcanic Broadback River, Eastmain River, and La Grande River belts (Fig. 8). The metavolcanic rocks, generally metamorphosed to greenschist and amphibolite grades, are surrounded and intruded by gneissic and massive felsic plutonic rocks. There is field evidence for more than one volcano-plutonic cycle.

The Opatica, Nemiscau River, and Opinaca River areas include abundant metasedimentary rocks, mainly wacke and conglomerate with mafic igneous rocks, metamorphosed to grades ranging from greenschist to amphibolite and locally granulite facies. The metasedimentary rocks are intruded by granites, many of which originated by anatexis of the metasediments, and have generally east-west structures formed by at least two phases of deformation. The metasedimentary domains are bordered in part by metavolcanic rocks but stratigraphic relationships between the metavolcanic and metasedimentary sequences are not well known. In the La Grande River area metavolcanic rocks apparently overlie metasedimentary rocks, whereas in the Eastmain River area the reverse is apparently true. Stratigraphic relationships have probably been complicated tectonically (Franconi, 1978).

Thus, it is proposed that the James Bay region be subdivided into the Opatica, Nemiscau River, and Opinaca metasedimentary Subprovinces and the La Grande River volcano-plutonic Subprovince (Fig. 6). Further work in the region may provide the basis for additional subdivisions, such as the "Broadback River Subprovince".

Three domains are tentatively distinguished in the Ungava region on the basis of variations in metamorphic grade, structural trends, and lithology (Figs. 6 and 8). A central area extending eastward from Hudson Bay consists mainly of tonalite and granodiorite orthogneiss and plutons with enclaves of mafic gneiss and metasediments and two small metavolcanic belts (Ciesielski, 1983). The dominant structural trends in the gneisses are east-west where they are mainly in amphibolite grade. In the southwest, however, highly-deformed granulite-facies gneiss include areas of subhorizontal gneissosity.

Areas in the north and southeast comprise granulite and amphibolite facies gneiss, including felsic and intermediate orthogneiss, paragneiss, and mafic gneiss, with abundant pre- and syn-kinematic metamorphosed felsic plutons and minor post-kinematic intrusions. Both east-west and north-trending structures are present but their relative ages are unknown. Areas of subhorizontal gneissosity occur throughout much of central Ungava and suggest large-scale doming and uplift of high-grade rocks that may represent the basement upon which the supracrustal sequences of the James Bay region were deposited. They may also constitute an older nucleus of continental crust onto which younger volcanic and sedimentary accumulations were accreted.

Few isotopic age determinations have been made in this part of the Superior Province. Scattered K-Ar dates (Wanless, 1970, 1971), circa 2500 Ma and younger, probably reflect Late Archean uplift and cooling, or possibly Proterozoic overprinting (Brooks, 1980). A Rb-Sr age of 2600 Ma has been obtained from gneiss in the La Grande River area (Brooks, 1980). Tonalitic gneiss near Eastmain River has a Rb-Sr date of 3000 Ma (Verpaelst *et al.*, 1980) and a U-Pb zircon age of 2700 Ma (Gauthier, 1981). A granodiorite pluton in Minto Subprovince south of the Cape Smith Belt yielded a Rb-Sr errorchron age of 2685 ± 183 Ma (Taylor and Loveridge, 1981). Gneisses north of the Cape Smith Belt have Rb-Sr isochron ages ranging from 2934 Ma to 2569 Ma (Doig, 1983). A. Ciesielski has unpublished Rb-Sr dates of 2500 Ma for paragneiss of the Nemiscau River Subprovince and for mafic granulite of Minto Subprovince. The lack of absolute, or even relative, age relationships among the rock units and structural elements of Ungava region represents a second major gap in our knowledge of Superior Province geology.

It is proposed, therefore, that the Ungava region be subdivided into the Minto and Ashuanipi high-grade gneiss Subprovinces separated by the central Bienville plutonic Subprovince (Fig. 6).

## Summary

Proposed lithotectonic subdivisions of the Superior Province, based on structural, lithologic, metamorphic, age, and geophysical characteristics, are generally similar to those proposed by Douglas (1973). Minor differences in location of subprovince boundaries are attributable mainly to new mapping information. More radical departures occur in the west, where the "English River Subprovince" of Douglas, Stockwell and other workers is further subdivided into a metasedimentary English River Subprovince, a volcano-plutonic Bird River Subprovince, and a plutonic Winnipeg River Subprovince. West of James Bay, a plutonic Winisk Subprovince is tentatively proposed.

In Quebec, improved geological and geophysical data permit some new speculative subdivisions of the Ungava and James Bay region to be made. These include the Nemiscau River and Opinaca metasedimentary Subprovinces, the volcano-plutonic La Grande River Subprovince, the plutonic Bienville Subprovince, and the Minto and Ashuanipi high-grade gneiss Subprovinces.

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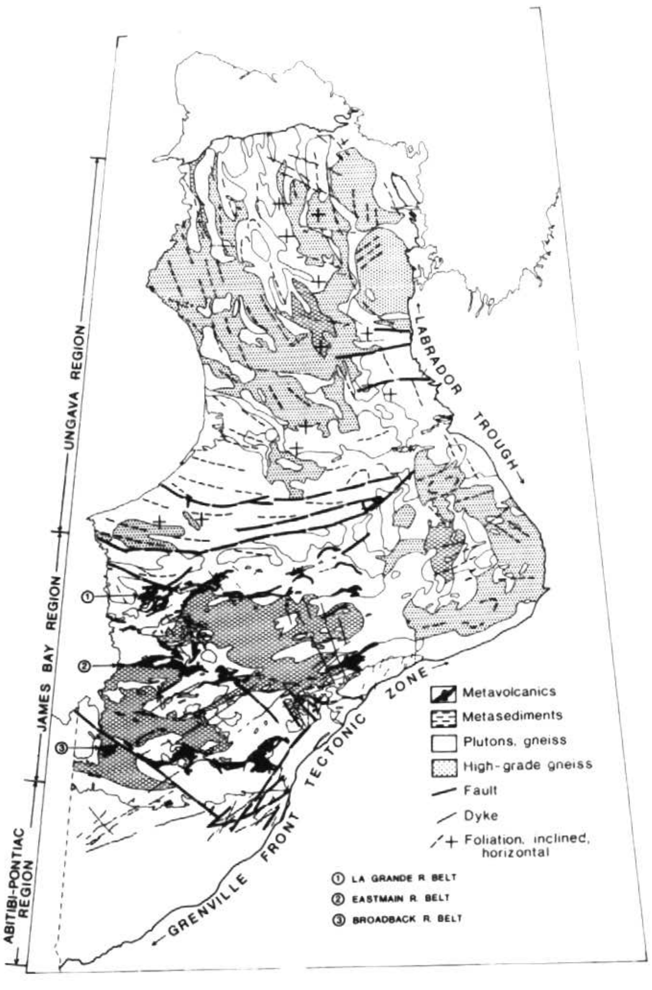


**Figure 8** *General geology of the Superior Province in the James Bay and Ungava regions of Quebec.*

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