# ANTARCTIC GEOLOGICAL 1:250,000 MAP SERIES MOUNT MURCHISON QUADRANGLE (VICTORIA LAND)

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### **EXPLANATION**

CENOZOIC MAGMATISM AT THE ROSS SEA MARGIN

McMURDO IGNEOUS COMPLEX

m Scree, glacial debris and moraine (m). Quaternary.

MELBOURNE ALKALI-BASANITE TO TRACHYTE-RHYOLITE (Mev) high differentiated alkali-volcanic suite forming major and composite strato-volcanoes (Mt. Overlord, Mt. Rittmann, Vulcan Hills, Berlin Dome) and other for centres. The radiometric ages range from 3.9 Ma at Mt. Rittmann to 8.3-7 Ma at Mt. Overlord and 14.5 Ma at Parasite Cone.

EANDER ALKALI-GRANITE AND SYENITE (Mg)

Ikali-feldspar granite and granophyre, alkali-granite and alkali-syenite with local transitions to volcanic-subvolcanic types. In several cases abbroic rocks occur in close association. The age of these rocks spans from 22 to 48 Ma.

POST-ROSS MAGMATISM AND SEDIMENTATION

### FERRAR VOLCANIC SUITE

baerial lavas, a few metres up to several ten metres thick, randomly separated by thinner sedimentary volcanogenic interlayers and pillow lavas, use lines: local beds and lenses of whitish marly siltstones, fine grained sandstones and minor black shales, with flora relics and conchostracans, ostly in the lower portion of the volcanic sequence. The Mesa Range basalts provide 178 Ma K/Ar ages.

change botenite (rd) of the Beacon Supergroup, immediately above the pre-decon peneplain. Black lines: major lenses and seams (meanly some ten meters thick) of Section Peak Formation sandstones forming sandwich be interlayers within the Ferrar Dolerite sills. A K/Ar age of 174±10 Ma has recently been reported from Archambault Ridge. **BEACON SUPERGROUP** 

Mainly fluviatile, cross-bedded, coarse- to medium-grained sandstone with a feldspathic to quartzose composition. Minor intercalations of conglomerate, black shale, carbonaceous or noncarbonaceous silty mudstone and minor coal occur as well. A Middle to Late Triassic age is testified by the presence of *Dicroidium odontopteroides* at Vulcan Hills.

ADMIRALTY IGNEOUS COMPLEX High level I-type granitoid suite ranging in composition from tonalite to monzogranite, with major granodiorite. The emplacement took place between 380 and 400 Ma, and cooling ages generally fall before 350 Ma.

ndesite, rhyolite and rhyolitic porphyries with minor olivine basalt, basaltic andesite, pyroxene-hornblende feldspar-phyric andesite or dacite. nese rocks form a layered sequence of flows, sills and volcanoclastics, in places crossed by an andesitic, dacitic and rhyolitic dike swarm. ecent age determinations on samples from Mt. Montreuil produced a Rb/Sr isochron of 356±16 Ma and K/Ar values on biotite of 356±2 Ma. TERRANES AND UNITS OF THE ROSS OROGEN

**WILSON TERRANE** 

### GRANITE HARBOUR IGNEOUS COMPLEX

ANITE HARBOUR GRANODIORITE AND GRANITE (GHgr)
n- to post-kynematic biotite granite, granodiorite and tonalite intruded in the Wilson metamorphic complex before 480±20 Ma (cooling ages). At southern end of the Aviator GI. intrusive breccia (a), made up of migmatite gneiss blocks and pods in a granitoid matrix, forms large and thick

RANITE HARBOUR GABBRO AND ULTRAMAFITE (GHga)
orite, gabbro, pyroxenite, and serpentinite, affected by amphibolite facies re-equilibration followed by a greenschist facies overprint. In places, e severe deformation linked to the greenschist event caused a complete transformation in chlorite-actinolite schist. No radiometric age data is GRANITE HARBOUR TONALITE (GHt)
Gabbro, tonalite, diorite and granodiorite suite affected by a more developed foliation. An age of 505.0±8.3 Ma has been obtained from samples south of Whitcomb Ridge.

WILSON METAMORPHIC COMPLEX REENSCHIST FACIES METASEDIMENTS (Wg) sandstone, slate, phillyte and metalimestone, often contact metamorphosed. The age is unknown, but a Precambrian to Cambrian age is nonly inferred. Local name: Priestley Formation.

stromatic migmatite with minor agmatitic varieties, hornblende gneiss including some small and irregular amphibolite layers, and calc-silicate iorizons alternating with fine-grained biotite gneiss. Biotite cooling ages fall around 475-480 Ma. Local name: Murchison Formation.

Fine- to medium-grained biolite schist with minor intercalations of quartz-biotite metasandstone. Biotite cooling ages indicate that metamorphism is older than 480 Ma. Local name: Retreat Hills Schist, Priestley Schist.

DESSENT RIDGE UNIT mphibolite facies metasediments derived from siliceous, carbonatic, pelitic and basic protoliths. Phyllonites with retrogressive imprint to greenschist sies are present along main shear zones. The metamorphic conditions are T = 520-600°C and P = 6-8 kb. Biotite ages range from 459-473 Ma Ar) to 475-477 (40Ar)<sup>39</sup>Ar, single grain). DESSENT METASEDIMENTARY SUITE (Dm)

#### BLACK SPIDER GREENSCHIST (Bbs) enish schist, black shale and phyllite, mafic metavolcanites, with major metaconglomerate bodies formed by dominant mafic and acid rbeds of psammitic and calc-silicate types also occur. The metamorphic grade is referrable to the biotite zone of the greenschist facies.

**BOWERS TERRANE** 

**BOWERS SUPERGROUP** 

hickly-bedded, whitish to reddish, fluvial to deltaic quartz-pebble conglomerate and quartzite, with minor intercalations of red silty mudstone. In the most common variety comprises a sequence of middle rose-coloured quartzite, pebble conglomerate and pebbly sandstone. A Late nis group is formed by two units which partly interfinger, the sedimentary Molar Formation and the Glasgow Spilite.

MOLAR FORMATION (Bmo) - This formation consists of a well bedded graywacke-mudstone sequence with volcanoclastic detrital lenses and minor siltstone interbeds. The age was established as Middle Cambrian or older, on the basis of the fossil content found north of this quadrangle (at Neall LASGOW SPILITE, VOLCANIC BRECCIA and TUFF (Bgl) - Submarine volcanic sequence constituted by massive and banded lava flows, pillow ava, volcanic breccia, tuff and tuffite layers, with subordinate interbeds of slate, tuffitic graywacke and minor quartzite, chert and limestone. The nterfingering relations with the Molar Formation indicate a similar age (Middle Cambrian or older).

## Geological boundary.

√26 ★ b Bedding, (a) inclined, (b) vertical.

√a 

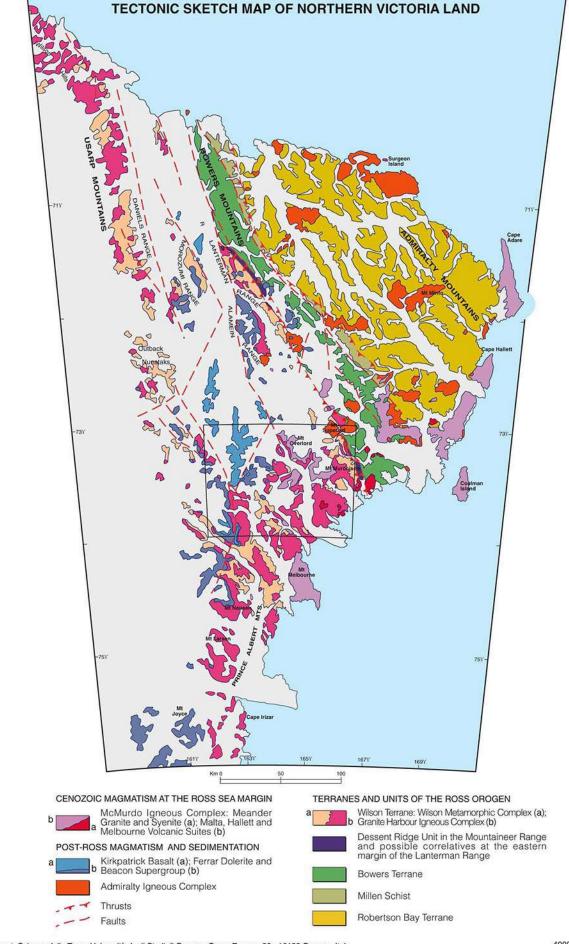
★ b Regional schistosity and cleavage, (a) inclined, (b) vertical.

b Mineral and stretching lineation, (a) inclined, (b) horizontal. Spatter and cinder cone. Ja h Axial plane trace, (a) anticline, (b) syncline.

a b Fold axis, (a) inclined, (b) horizontal.

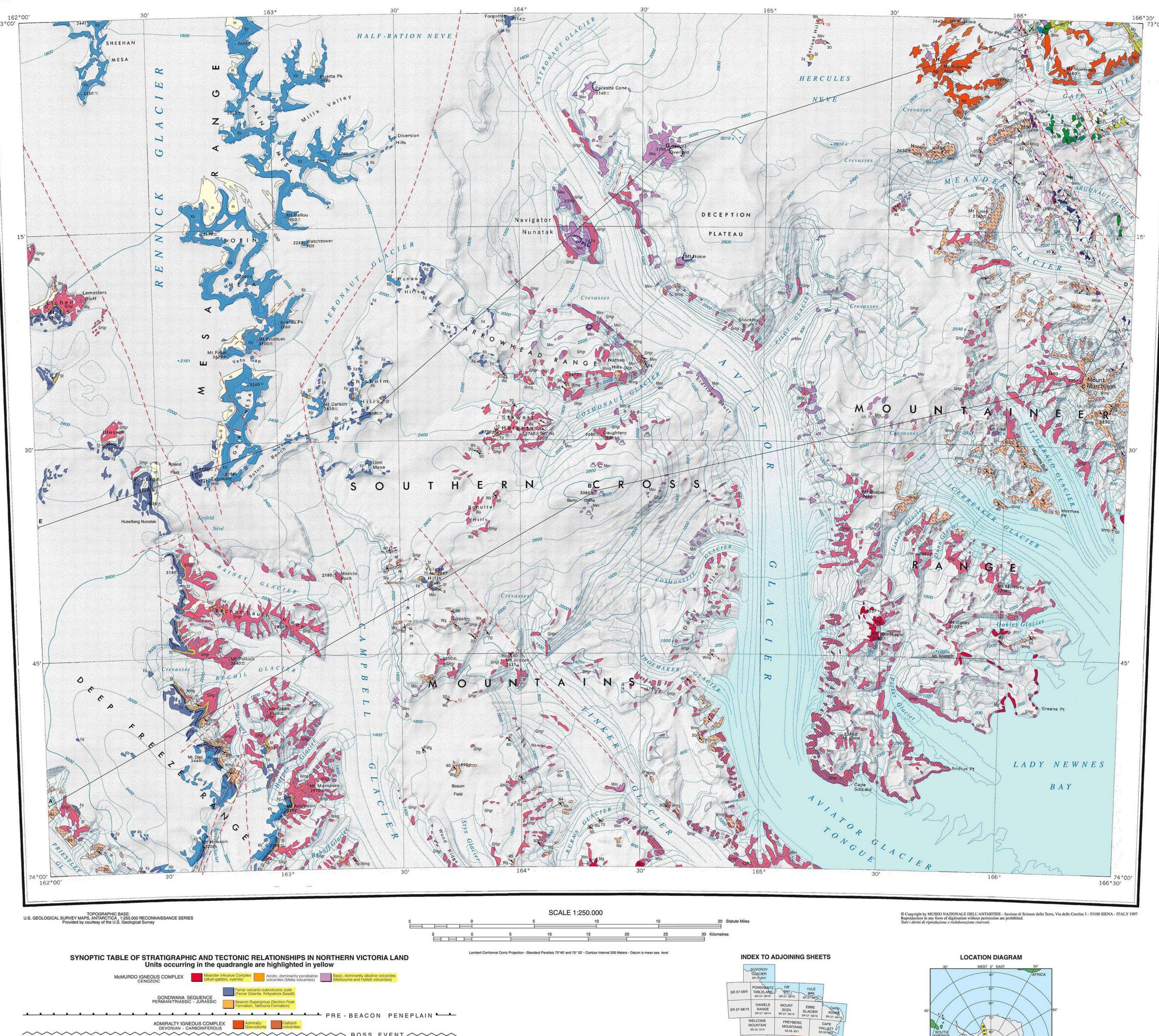
→ Thrust; teeth on overthrust side. - - Fault; tick (on the downthrown side) or arrows where the sense of motion is known. Crater, sink-hole, caldera rim.

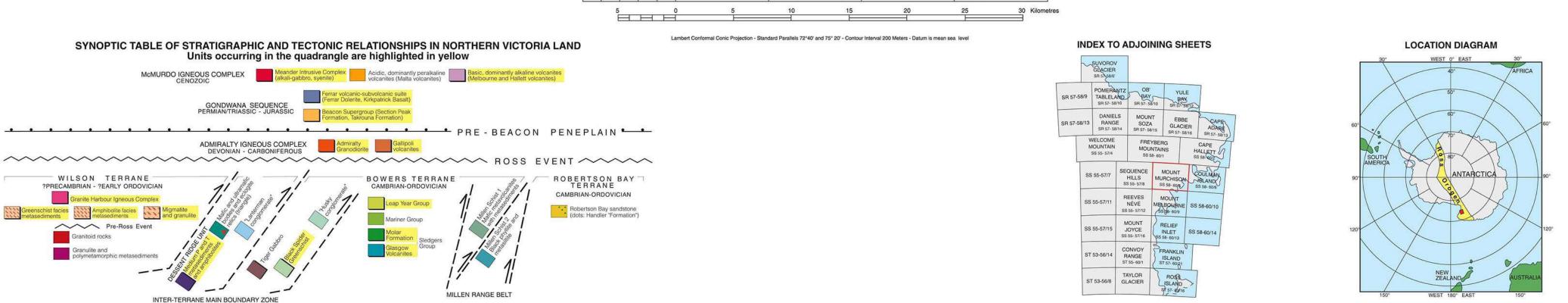
Active volcano (fumarolic activity).

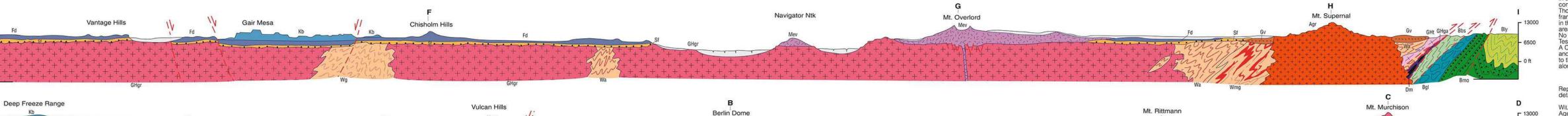


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Age data on the paraschists of the WT are summarized by Vita-Scaillet et al. (1994) and Vita-Scaillet & Lombardo (1997). Samples from the Retreat Hills-Mt. Murchison area give K/Ar mineral ages (biotite and muscovite) ranging between 465 and 491 Ma (with no relation to the metamorphic grade); the weight average is 480±4 Ma. This mean value is in good accordance with 40Ar/39Ar single-grain analyses on the same minerals, which provided ages between 477± and 480±2 Ma (three biotites) and of 478±2 (two muscovites). High grade rocks to the SW provided K/Ar ages around 468-474 Ma at Shoemaker GI., and 455 Ma at Burns GI. The paraschists at the SW corner of the quadrangle have not been dated, but their on-strike correlatives cropping out in the Mt. Levick area, not far to the SE (Mount Melbourne quadrangle), give K/Ar ages in the range 455-465 Ma. Granite Harbour plutonic rocks, cropping out NE (Cape ibbald) and SW of tinker GI. (Mt. Mc Gee, Mt. Jiracek) gave WR-biotite cooling ages in the range 450-465 Ma (Tonarini e Rocchi , 1994, and reference:

PREVIOUS WORK

The region considered here was first visited during the Heroic Age of Antarctic exploration. Scott's Northern Party surveyed the area around Terra Nova Bay in 1912, before being forced to winter-over in a snow-cave on Inexpressible Island (Priestley, 1914, 1915; Smith & Priestley, 1921). In the sixtles several New Zealand field parties (Nathan & Schulte, 1968; Nathan, 1971) surveyed northern Victoria Land (NVL) and this quadrangle, establishing the overall framework of regional geology (see Gair et al., 1969, and Nathan & Skinner, 1972, for geological maps and discussion on earlier work). During the 1981-82 International NVL Project, New Zealand and USA geologists (Stump, 1986) investigated the field relations, petrology and geochemistry of the Paleozoic granitoids (Borg et al., 1986, 1987) and of the Jurassic tholeities (Elliot et al., 1986). During the 1982-83 season, NVL was visited by the GANOVEX III German expedition (Roland, 1984). Investigations focused on the geology and petrology of the metamorphic basement complex in the Mountaineer Range (Kleinschmidt et al., 1984), on regional patterns of metamorphism (Grew et al., 1984) and especially on the geology and tectonic implications of the newly discovered continuation of the Bowers Structural Zone (Adams & Kreuzer, 1984; Gibson et al., 1984; Tessensohn, 1984). The GANOVEX Team (1987) also produced a 1:500,000 geological map of NVL. In the 1984-85 season the aeromagnetic survey by GANOVEX IV covered part of NVL (Durbaum et al., 1989) Damaske et al., 1989); though the work focused on geophysical investigations, some geological activity was carried out (Roland et al., 1989) and resulted in a geological map of the area between Outback Nunataks and Reeves GI. (Schubert & Olesch, 1989). From the 1985-86 season Italian geologists investigated the region between David GI. and Mariner GI, and a 1:500,000 geological map of the same area (Carmignani et al., 1987) was produced. The German and Italian expeditions of the following years triggered the pub SHORT DESCRIPTION OF GEOLOGY The Mount Murchison quadrangle encompasses an Early Paleozoic metamorphic basement, involved in the Ross Orogen (Late Cambrian - Early Ordovician The Mount Murchison quadrangle encompasses an Early Paleozoic metamorphic basement, involved in the Ross Orogen (Late Cambrian - Early Ordovician), Late Paleozoic intrusive and volcanic rocks, and a flat-lying cover spanning from Triassic to Quaternary time, with large stratigraphic gaps. The Early Paleozoic basement consists of two main terranes, the Wilson Terrane (WT) and the Bowers Terrane (BT). The WT is prevalent in the quadrangle, and includes low to medium-high grade metamorphic rocks of Precambrian -?Cambrian age, intruded by large bodies of the Late Cambrian-Early Ordovician Granite Harbour Igneous Complex. The BT occurs in the NE corner and consists of Middle to Late Cambrian low grade sedimentary and volcanic rocks. The Dessent Ridge Unit (DRU) is a minor fault-bounded tectonic unit between the WT and the underlying BT. The contact between the terranes is characterised by NNW-SSE trending large scale shear zones dipping to WSW. The WT was eastward thrusted onto the DRU and BT under amphibolitic and greenschists facies conditions, respectively. The Devonian Admiralty intrusives and Gallipoli volcanic rocks were emplaced in both terranes and supply an upper time constraint for the docking of the WT and BT. After the Admiralty-Gallipoli magmatic event, the Paleozoic basement was uplifted and eroded. On the resulting peneplain surface, the Triassic Beacon Sandstone deposited and in turn was covered by large flows of the Jurassic Kirkpatrick Basalt. The Jurassic Ferrar Dolerite formed sills chiefly along the basal Beacon horizon. The youngest event was the emplacement of the Cenozoic McMurdo igneous rocks, which consist of the older Meander intrusive suite and of the younger Melbourne alkali-volcanic suite.

## LITHOSTRATIGRAPHY

Metamorphic rooks
Greenschist facies metasediments (Wg) crop out at Priestley GI. and in a small area E of Campbell GI., between Vulcan Hills and Burns GI. Amphibolite facies metasediments (Wa) crop out in three separate belts occurring, from W to E, (1) along the northeastern side of Priestley GI. (SW corner of the quadrangle); (2) from the western slopes of Tinker GI. to Schulte Hills and Stewart Heights; (3) in the Retreat Hills area (NE sector of the quadrangle). Migmatite gneisses (Wmg) also form three belts: the first along the western side of the upper Campbell GI. (mainly as septa inside the prevalent intrusive rocks); the second belt occurs along Aviator GI., from the southern boundary of the quadrangle to Arrowhead Range; the third belt is wider and comprises all the outcrops in the Mountaineer Range from Cape King to Hobbie and Whitcomb Ridges. Migmatitic rocks are stromatic migmatites with minor agmatitic varieties; other lithotypes are: (1) leucosomes (Mt. Murchison, Husky Ridge, Straight GI. and the Mt. Kinet area); (2) Mg-hornblende gneiss (Mt. Murchison and Straight GI.), hosting mall, irregular amphibolite layers; (3) calc-silicate layers alternating with fine-grained biotite gneiss (Hobbie and Whitcomb Ridges, occasionally also present at the northern slopes of Mt. Kinet, at Husky Ridge, Straight GI. and the Mt. Kinet area); (2) Mg-hornblende gneiss (Mt. Murchison and Straight GI.), hosting mall, irregular amphibolite layers; (3) calc-silicate layers alternating with fine-grained biotite gneiss (Hobbie and Whitcomb Ridges, occasionally also present at the northern slopes of Mt. Kinet, at Husky Ridge, and Mt. Murchison). No granulite relics were found within these high grade metamorphic rocks, although granulites are present in the Mount Melbourne quadrangle (along the western side of the lower Campbell GI. and at Kay Island). The protoliths of all the metasediments seems to belong to a unique very thick sequence of fine- to medium-grained sediments (Precambrian-?Cambrian) that underwent metamo

pressure type recognized by Grew et al. (1984), although part of the intermediate pressure belt of these authors has to be considered as an independent tectonic unit (i.e. the DRU).

Granite Harbour Igneous Complex

During the last ten years, some petrographic and geochemical differences of regional significance have been described for these rocks in Victoria Land, particularly in the area between Aviator Gl. and the Mountaineer Range. Borg (1984), Borg et al. (1986), and Vetter & Tessensohn (1987) stated that these granitoids occur in two belts, an eastern and a western one. The western belt is made up of 5-type, peraluminous, two-mica and mainly K-feldspar porphyritic granite; coeval I-type hornblende granodiorite, diorite and tonalite form minor plutons and dykes. The eastern belt (cropping out on both sides of Fitzgerald Gl.) consists of I-type, mainly granodiorite, to tonalitic intrusive rocks. Contrasting features are also in the isotopic signature (Rocchi et al., 1994). These belts trend NW-SE throughout the WT, and were interpreted as the magmatic signature of an active continental margin.

Granite Harbour Granodiorite and Granite (GHgr) - These rocks form the large massif of the Deep Freeze Range, up to Lichen Hills. Other large bodies crop out in the Southern Cross Mountains, in the Arrowhead Range-Navigator Nunatak divide, in the Mt. Monteagle-Mt. Casey massif and in the upper Fitzgerald Gl. Along the SW side of this glacier, transitions of the granite is more migratite greiss can be observed. On the western and southern slopes of the Mt. Monteagle massif, intrusive breccia made up of blocks and pods of migmatite gneiss can be observed on the western and southern slopes of the Mt. Monteagle massif, intrusive breccia made up of blocks and pods of migmatite gneiss within a granitic matrix is referred to as Aviator Agmatites by the GANOVEX III geologists (1987). KVA biotite ages of 484 and 482 Ma (Vita-Scaillet & Lombardo, 1987) are available for the granitic rocks at Mt. Murchison; these cooling ages f

This unit occurs as a narrow fault-bounded tectonic unit from the Ross Sea (in the Coulman Island quadrangle) to the Gair GL, where it wedges out. Amphibolite facies metamorphism in this unit occurred with pressures considerably higher than in the WT (P = 6-8 Kb at T = 520-600°; Kleinschmidt et al., 1984; Capponi et al., 1988), and was then overprinted by a greenschist facies retrogressive metamorphism. Granulite facies relics were found at Frank Point (Scambelluri et al., 1997). Garnet-bearing aplitic dykes also occur at the same locality. n this quadrangle the BT comprises the Black Spider Greenschist and the Bowers Supergroup of Cambrian age.

Black Spider Greenschist

These rocks (Bbs) form a narrow NW-SE trending belt along the western border of the BT, and in this quadrangle crop out between Meander and Gair GI.
and at Mariner Plateau, where they contain metavolcanic rocks derived from mafic tuffs, pyroclastics, and pillow lavas. As discussed by Gibson et al. (1984),
these rocks appear to be the higher grade (greenschist facies, biotite zone) equivalents of the Bowers Supergroup, especially of the Sledgers Group, from
which they differ in metamorphic grade and degree of deformation. The higher metamorphic grade is showed by the occurrence of widespread biotite in the
westernmost outcrops, close to the tectonic contact with the DRU.

Bowers Supergroup
The rocks of this supergroup show a metamorphic grade between the prehnite-pumpellyite facies and the chlorite zone of the greenschist facies.
Sledgers Group - This group was proposed by Laird & Bradshaw (1983) and comprises two heterogeneous formations, the Glasgow spilite, volcanic breccia and tuff (Bgl) (Laird & Bradshaw, 1982) and the Molar Formation (Bmo). The first one is also named Glasgow Formation (Laird & Bradshaw, 1983) and in this quadrangle forms only one small outcrop SE of Whitcomb Ridge; the Molar Formation was defined by Laird et al. (1982) and in this quadrangle occurs south of Gair GI.

Leap Year Group (Bly) - This group unconformably rests on the older formations, and its sequence broadly represents an upward-fining clastic sediment. The basal pebble and cobble conglomerate passes upwards into the thicker central part of the sequence, consisting of quartzite, pebble conglomerate and pebbly mudstone, which in turn gives way to quartzite and siltstone. In this quadrangle, Leap Year rocks occur south of the lower Gair GI. and in the northern and eastern slopes of Mt. Montreuil. ADMIRALTY IGNEOUS COMPLEX

Admirally Granodiorite Suite
These I-type plutonic rocks (Agr) form discordant plutons and minor intrusions, mainly within the Robertson Bay Terrane (RBT) and the BT. They range from

these ryspe plutonic tocks (Agr) form discordant plutons and minor initiations, mainly within the Addension Bay Terraine (NBT) and the BT. They range non-tionalite to monzogranite, with a clear prevalence of granodiorite. In this quadrangle the Admiralty Granodiorite forms the Mt. Supernal-Mt. Montreuil massil which stitches the contact between the WT and BT providing an age constraint for their tectonic docking. Two radiometric ages were reported from Mt Supernal: a K/Ar biotite age of 354±10 Ma (Nathan, 1971; Hulston & McCabe, 1972) and a Rb/Sr biotite age of 364±20 Ma (Stump et al., unpubl. data, 1986) New mineral ages were obtained by Henjes-Kunst & Kreuzer (1993). A granite sample from an outcrop 3.5 km NE of Mt. Supernal, yelded a K/Ar model age of 347±3 Ma on biotite. Furthermore, a granitic dike cutting an outcrop of Gallipoli volcanic rocks provided a similar age within the limits of error Gallipoli Andesite-Rhyolite Sequence

Gallipoli Andesite-Rhyolite Sequence
These volcanites (Gv) occur at Mt. Anakiwa and in the Mt. Supernal-Mt. Montreuil area. The Gallipoli sequence is often considered younger than the Admiralty
Granodiorite, and in the literature a number of outcrops are reported, where the former overlie the latter, as at Mt. Ajax (Cape Adare quadrangle, GANOVEX
Team, 1987). In contrast to this, very clear intrusive relationships of the Mt. Supernal Granodiorite into the Anakiwa volcanites can be observed in some outcrops
on the southern slopes of Mt. Supernal (i.e. at 165°49′E, 73°06′S). The time intervals for the emplacement of both the Mt. Supernal Granodiorite (364-347 Ma)
and Anakiwa volcanites (375-323 Ma) do not disagree with this field observation. Henjes-Kunst & Kreuzer (1993) have recently demonstrated the geochemical
similarity of the Gallipoli and Admiralty suites. In addition, a number of new ages for these volcanites confirms the close age relationships of the two units. A
Rb/Sr whole-rock isochron on samples of the Gallipoli suite from the Mariner Plateau (north of Mt. Montreuil, Freyberg Mountains quadrangle) yelded an age
of 356±16 Ma. This result is corroborated by a K/Ar mineral date of 356±2 Ma on biotite from one of the same samples. These dates confirm that the Admiralty and Gallipoli suites are geochemically related, and are also of similar age. The base of the Beacon Supergroup is represented by a remarkable peneplain surface which is equivalent to, but younger than, the Kukri Peneplain as defined in the Dry Valleys (Barrett et al., 1986). Above this surface the clastic Beacon deposits unconformably rest on many lithotypes of the underlying basement. The Beacon Supergroup rocks occurring in this quadrangle belong to the Section Peak Formation (Collinson et al., 1986).

Section Peak Formation
At the type locality (Section Peak, Lichen Hills, close to the west border of the map) this clastic formation (Sf) forms a 30-50 m-thick sequence of arkosic sediments which lie above the peneplaned surface of the Granite Harbour Igneous Complex and below the Ferrar Dolerite. The recent founding of Dicroidium odontopteroides at the Vulcan Hills (Tessensohn & Mädler, 1987) confirms the already known Middle to Late Triassic age. The Section Peak Fm. differs from the Permian Takrouna Fm. (not occurring in this quadrangle) that is thicker and contains characteristic volcanic detritus. Good outcrops are at the Lichen, Illusion, and Vulcan Hills, in the Deep Freeze Range and at Stewart Heights. The Beacon sandstone is also characterised by diffuse occurrence of large intrusions of Ferrar Dolerite sills parallel to the bedding.

FERRAR VOLCANIC SUITE Ferrar Dolerite
The Ferrar Dolerite (Fd) consists of tholeiitic dolerite sills and minor dykes, usually emplaced inside the lower part of the sedimentary sequence of the Beacon Supergroup. Major outcrops are in the Deep Freeze Range up to the Lichen Hills, at Linn Mesa, at the southern end of the Retreat Hills and at the Forgotten, Chisholm, Runaway and Vulcan Hills. A K/Ar age of 174±10 Ma has recently been reported for these rocks from this quadrangle (Brotzu et al., 1990). Kirkpatrick Basalt
The Kirkpatrick Basalt (Kb) consists of amygdaloidal lavas with rare tuffaceous and sedimentary interbeds. The lavas are typical tholeiites with two pyroxenes, plagioclase and glassy mesostasis. Fossil trees occur at Tobin Mesa and Suture Bench. The lowermost part of the sequence, the Exposure Hill Formation, was distinguished as a separate formation by Elliot et al. (1986). It consists of volcanoclastic matrix-supported sediments with elements up to some metres in size; vegetal relics are common, and marly sandstones and marls occur at some level. In this quadrangle the Kirkpatrick Basalt flows forms the huge sequence of the Mesa Range (southern corner of the Rennick Graben) and the uppermost rocks of the Deep Freeze Range. North of Shafer Peak, (Mount Melbourne quadrangle), conchostracans of probable Jurassic age have been found in black shale levels within marly sandstones at the top of the first volcanoclastic level, unconformably lying on the Section Peak Formation. K/Ar dates from the Mesa Range indicate 178 Ma as minimum age for the whole lava sequence (Elliot & Foland, 1986). A 40Arf 39Ar age of 174.2±1 Ma was obtained by McIntosh et al. (1986).

This complex comprises plutonic and volcanic rocks of alkaline character and bimodal composition. The plutonic rocks occur as isolated plugs in the basement, aligned along a NE-SW trend, parallel to the Borchgrevink Coast between Aviator and Mariner GI., whereas the volcanic rocks occur as scattered stratovolcanoes. Meander Alkali-Granite and Syenite
These rocks (Mg) form intrusive bodies at the top of Mt. Monteagle and ESE of Mt. Casey. Other outcrops are near the southern boundary of the quadrangle (Burns Gl.) and in the southern slopes of Mt. Murchison.

This strongly differentiated alkali-volcanic suite (Mev) forms large and composite stratovolcanoes as Mt. Overlord, Mt. Rittmann and Berlin Dome, as well as other minor volcanic centres. Mt. Overlord has a predominant composition of intermediate and felsic alkaline lavas and minor basalts (Noll, 1984) with ages of 14.5 Ma at Parasite Cone and 7.0-8.3 Ma at the main volcanic edifice (Kyle & Cole, 1974; Kyle & Noll, 1990; Armienti & Tripodo, 1989). The recently discovered Mt. Rittmann volcano, north of Fitzgerald GI., consists of mildly undersaturated alkaline basalt to peralkaline trachyte with an average age of 3.9 Ma (Armienti & Tripodo, 1989; Bonaccorso et al., 1989). Furthermore, this volcano shows ongoing fumarolic activity.

The small volcanic centres usually consist of basanitic to basaltic pipes and vents. They occur on either side of the upper Aviator GI. (around Navigator Nunatak), at Berlin Dome, between Aviator and Icebreaker GI., and in the area of Mt. Supernal.

> TECTONICS **ROSS TECTONICS**

MILSON TERRANE
In the western and central part of the quadrangle, the regional schistosity is the axial plane foliation of isoclinal folds which deform an earlier metamorphic layering. The structural features of the Mt. Murchison area have been described by Kleinschmidt et al. (1984) and by Castelli et al. (1997). The latter describe two main deformative phases (D1 and D2) well recognizable at Retreat Hills and Niagara Icefalls. The first phase isoclinal folds and associated schistosity are in turn deformed by later, asymmetric, isoclinal folds, with a more or less penetrative crenulation cleavage. Cleavage development increases from north of south and, south of Hobbie Ridge, the cleavage trends NW-SE and dips moderately toward SW, being the main regional foliation. Southward in the Mt.Murchison area, cleavage development was more advanced and results in a severe, even complete, transposition of the older foliation. The second deformation phase was synchronous with metamorphism which reached high grade conditions in the region between Aviator and Meander GI., and medium to low grade conditions north of the Hobbie Ridge-Whitcomb Ridge line. In general, this deformation phase was characterized by non-coaxial strain which generated both folding and shear bands. The latter appear to be more pervasive approaching the WT-DRU contact. The shear deformation produced widespread stretching lineations, and a high dispersion of hinge lines of the folds on their own axial planes, frequently parallel to the shear bands. S-C surface systems are also widespread and indicate a northeastward tectonic transport. These kinematic indicators show the same character and attitude as those within the underlying DRU.

DESSENT RIDGE UNIT In the DRU the most common structural feature is a penetrative schistosity with a marked stretching lineation. The schistosity dips moderately to steeply toward SW and bears prevalent down-dip stretching lineations. This lineation is chiefly outlined by preferred orientation of the metamorphic minerals as large amphiboles up to 5 cm in size, that are sometimes affected by stretching and boudinage. The structural features of these rocks recall the overall structure of the WT metasediments, and were described by Kleinschmidt et al. (1984). At least three deformation phases are recognizable. The first two are responsible for folding (F1 and F2) with pervasive axial plane schistosities (S1 and S2); the third phase is related to shear deformation along discrete bands. Such S2 is the most evident foliation in the field and S1 is preserved only inside the microlythons. Meso and megascale F1 and F2 folds and related interference patterns are rather uncommon. The amphibolitic mineral assemblage synkinematic to the first deformation phase, was deformed by the second phase, that developed under the same thermal conditions. The third, shear-related deformation, which formed regional scale shear bands with S-C mylonite structures, is widely linked to the greenschist retrogression. Approaching the contact with the BT, such a deformation is more and more developed and penetrative. Kinematic indicators show transpressive motion with prevalent top-to-NE thrusting coupled with minor dextral strike-slip component. Additional observations are reported in Capponi et al. (1997) and Flöttmann (1997).

This low-grade metamorphic belt is the more deformed and metamorphosed portion of the BT. A first deformation phase generated isoclinal folds with a pervasive axial planar slaty cleavage; the fold axes trend NW-SE and show significant variation in plunge. Synkinematic metamorphic minerals (muscovite+chlorite+quartz+biotite± epidote) are aligned along the cleavage surfaces, and the strongly elongated pebbles of the conglomeratic levels are parallel to the local fold axes. A second deformation event produced a locally pervasive crenulation cleavage, which is the axial planar foliation of tight to isoclinal folds, with short limbs and thickened hinges. Locally, this cleavage is the most important foliation in the field.

Bowers Supergroup
Unlike the WT and the DRU, in this supergroup the well defined lithostratigraphic units and their internal bedding allowed reconstruction of some NE-facing anticlines and synclines ranging from a few to several kilometres in size. In the Gair GI.-Argonaut GI. area, two anticlines with the Molar Formation at the core and one syncline with the Leap Year Group at the core represent the main structures. These structures continue to the SE in the adjacent quadrangle (Coulman Island), and to the NW they abut against the Mt. Montreuil intrusion. An axial planar slaty cleavage is well developed mainly in the fine-grained layers. The foliation and the axial planes moderately to steeply dip to SW. The fold axes show a mean NW-SE trend, with both northwestward and southeastward plunges. These structures are weakly deformed by a late crenulation. THE WILSON-DESSENT BOUNDARY

THE WILSON-DESSENT BOUNDARY
This contact developed under amphibolite facies conditions as testified by fabrics and mineral assemblages in both WT and DRU, as well as by the depth of emplacement of synkinematic Granite Harbour Tonalite (6-8 Kb) that marks the main thrusting structure between WT and DRU. Greenschist facies retrogression also affected the tectonic boundary due to a later deformative phase. Furthermore, mafic and ultramafic rocks belonging to the Granite Harbour Gabbro and Ultramafite, along the tectonic contact show a similar deformative and metamorphic evolution from amphibolite to greenschist facies conditions. This retrogressive imprint becomes less evident southwards. THE WILSON-BOWERS BOUNDARY

THE WILSON-BOWERS BOUNDARY
The most outstanding feature of the eastern part of the quadrangle is the contact between the WT and the BT, with the interposition of the DRU. This boundary was studied in detail during the ItaliAntartide and GANOVEX expeditions and the results are summarized in Capponi et al. (1997). Along this contact, the sharp contrast in metamorphic grade between the medium to high grade WT+DRU and the low to very low grade BT points out that a major part of the crust in between has been cut out by thrusts and minor dextral strike-slip faults, resulting in severe crustal telescoping between WT and BT. The tectonic boundary between WT and BT with the interposed DRU is a large scale out of sequence thrust, cross-cutting the previously developed structures and metamorphic isograds in the underlying BT. The first stage of thrusting was characterised by synkinematic metamorphism, that was retrogressive from amphibolitic to greenschist facies for the WT+DRU and prograde for the BT as testified by occurrence of the Black Spider Greenschists belt close to the boundary. The deformation associated to the greenschist facies metamorphism postdates the Late Cambrian cooling age of the Granite Harbour Tonalite.

# POST - ROSS TECTONICS

The most striking and widespread feature related to the post-Ross tectonics is represented by the regional unconformity along the pre-Beacon peneplaned surface. This surface is the only record which testifies the post-Admiralty uplift and erosion of the Ross Orogen. The succeeding tectonic evolution resulted in the prominent lozenge-shaped area of the Mesa Range, at the SE termination of the Rennick Graben. The Rennick Graben consists of two rhomboidal grabens occupied by Kirkpatrick Basalt, corresponding with the areas of Litell Rocks to the north (Daniels Range quadrangle) and Mesa Range to the south. Tessensohn (1994) interpreted these basins as pull-apart structures linked to continental transcurrent faulting, which accommodates the transtensional strain between two symmetric areas of spreading, i.e. the SE Indian Ridge and the mid-Pacific Ridge. A wide portion of the southern pull-apart basin is comprised in the Mount Murchison quadrangle, and the inferred faults running from Archambault Ridge to Lichen Hills and from Mericle Rock to Forgotten Hills can be considered as the border faults of the basin.

Though pormal faulting, with pertical thorous up to 600 m at the head of Campbell GL (Roland & Tessensohn, 1987) is the most prominent feature of this tectonic. considered as the border faults of the basin.

Though normal faulting, with vertical throws up to 600 m at the head of Campbell GI. (Roland & Tessensohn, 1987), is the most prominent feature of this tectonic framework, minor reverse faults affecting the Beacon sandstones (south of Mt. Gibbs) and in the Kirkpatrick sequence (Gair Mesa) have been also observed in this quadrangle. Compressive structures are even more evident both north (Freyberg Mountains and Lanterman Range) and south (Shafer Peak-Mt. Cavaney area) of this quadrangle. Along these structures the basement crystalline rocks have been thrust both southwestward and northeastward over the cover rocks. No geometric relationship was observed in the field between the compressive and extensional structures, thus we cannot recognize their relative chronology. Tessensohn (1994) proposed the compressive structures to be linked to the strike-slip motions active during the development of the pull-apart basins A Cretaceous thermal event at 110 Ma (Delisle & Fromm, 1989) might be ascribed to the same event of crustal thinning and is probably responsible for the anomalous age data found in the Mesa Range rocks (Elliot & Foland, 1986; Foland et al., 1993). A more recent extensional tectonics of Cenozoic age, associated to the emplacement of McMurdo Igneous Complex and to the spreading of the Ross Sea, is represented by normal faults with a mainly NS trend, exposed along the east side of the Aviator Glacier

## RADIOMETRIC AGE DATA

Representative age indications on BT, Admiralty Igneous Complex and Meso-Cenozoic cover are reported in the preceding respective explanations. More detail can be provided for the WT and DRU, as follows.

K/Ar biotite ages from DRU metamorphic rocks (Vita-Scaillet et al., 1994; Vita-Scaillet & Lombardo, 1997) fall in the range 459-473 Ma, overlapping ages of the adjacent Mt. Murchison paraschists. 40Ar/39Ar single-grain analyses on the DRU rocks provide ages of 475±2.5 and 477±3 Ma (two biotites), and of 477±3.