Ministero dell'Università e della Ricerca Scientifica e Tecnologica Programma Nazionale di Ricerche in Antartide

# ANTARCTIC GEOLOGICAL 1:250,000 MAP SERIES RELIEF INLET QUADRANGLE (VICTORIA LAND)

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m Scree, glacial debris and moraine (m). Quaternary. TERRANES AND UNITS OF THE ROSS OROGEN **WILSON TERRANE** GRANITE HARBOUR IGNEOUS COMPLEX RANITE HARBOUR GRANODIORITE AND GRANITE (GHgr) to post-kynematic biotite granite, granodiorite and tonalite intruded in the Wilson metamorphic complex before 480±20 Ma (cooling ages). Local name: Larsen brite, b - Post-Kynematic, pink to reddish, K-feldspathic granite. Local name: Irizar Granite. gabbro, pyroxenite and serpentinite, affected by amphibolite facies re-equilibration followed by a greenschist facies overprint. In places, the severe deformation of the greenschist event caused a complete transformation in chlorite-actinolite schist. No radiometric age data is available. SYMBOLS Geological boundary.

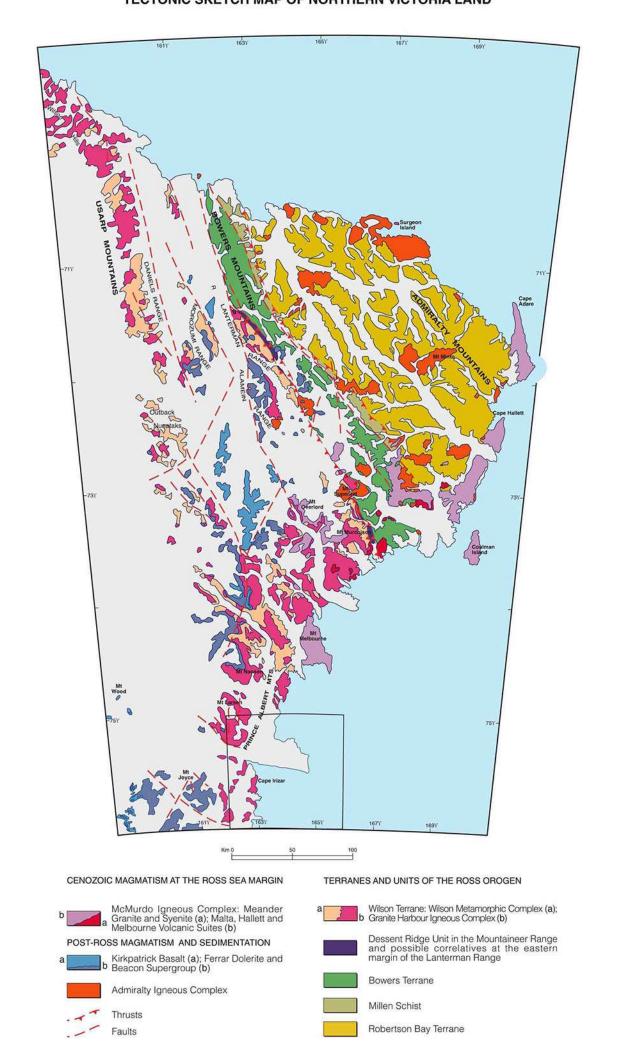
Magmatic fluidality.

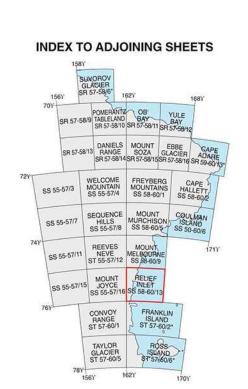
\* A Shot ACRUP 1993 - 1994

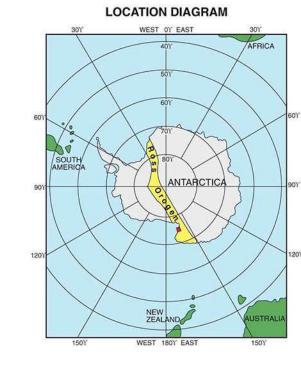
Fault; tick (on the downthrown side) or arrows where the sense of motion is known.

# TECTONIC SKETCH MAP OF NORTHERN VICTORIA LAND

Felsic and mafic dyke swarm. A lot of dykes, both felsic and mafic in composition, belong to the Granite Harbour Igneous Complex, but several mafic dykes pertain to

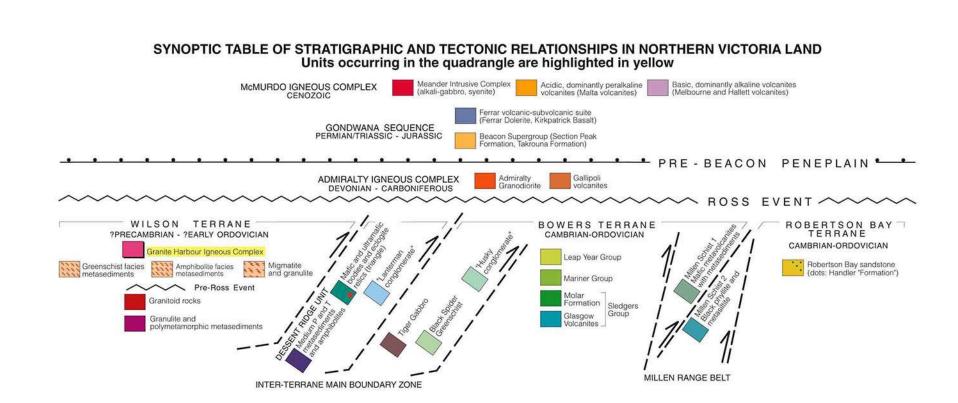






RELIEF INLET **GIGAMAP** GERMAN-ITALIAN GEOLOGICAL ANTARCTIC MAP PROGRAM





Lambert Conformal Conic Projection - Standard Parallels 72°40' and 75° 20' - Contour Interval 200 Meters - Datum is mean sea level



### GEOLOGICAL OUTLINES

Museo Nazionale dell'Antartide

## PREVIOUS WORK

The region considered here was first visited during the Heroic Age of Antarctic exploration. The Magnetic Pole Party of the Shackleton Expedition (1907 - 1909) crossed the Transantarctic Mountains at the David Glacier. The party included two geologists, Edgeworth David and Douglas Mawson, who did geological observations during the sledging toward the Magnetic Pole (David, 1909). Scott's Northern Party surveyed the region around Terra Nova Bay in 1912, before being forced to winter-over in a snow-cave on Inexpressible Island (Priestley, 1914, 1915, 1923; David and Priestley, 1914; Smith and Priestley, 1921). In the sixtles several field parties (Gunn and Warren, 1962; Ricker, 1964; Skinner and Ricker, 1968a, 1968b; Warren, 1969, Skinner, 1983), surveyed the area between sixties several field parties (Gunn and Warren, 1962; Ricker, 1964; Skinner and Ricker, 1968a, 1968b; Warren, 1969, Skinner, 1983), surveyed the area between McMurdo Sound and Terra Nova Bay establishing the overall framework of regional geology. In the 1985/86, geologists of the first ItaliAntartide expedition area carried out some geological investigations in Terra Nova Bay, which continued in the following seasons and produced a 1:500,000 geological map (Carmignani et al., 1987) comprising the Relief Inlet quadrangle. ItaliAntartide and Ganovex expeditions of the following years triggered the publication of a number of papers: contributions by Armienti et al. (1988); Biagini et al. (1989); Cimini et al. (1995); Coren et al. (1997); Delisle (1994a, 1994b); Fitzgerald and Baldwin (1997); Ghezzo et al. (1987); Mazzarini et al. (1997); Redfield and Behrendt (1992); Redfield et al. (1990); Reitmayr (1994, 1997); Rocchi et al. (1994); Salvini et al. (1997a, 1997b) are specifically related to the Relief Inlet quadrangle.

In the austral summer 1993/94 a joint scientific party including researchers from Germany, Italy and U.S. carried out an onshore-offshore geophysical transect, called ACRUP-1 experiment, along two east-west crustal transects at 76°S and 77°S for a total length of about 900 km (Della Vedova et al., 1994; ACRUP Group, 1995) from the Transantarctic Mountains across part of the West Antarctic Rifft System (Behrendt et al., 1996 and ref. therein). The experiment of the Vest Antarctic Rifft System (Behrendt et al., 1996 and ref. therein). The experiment of the Vest Antarctic Rifft System (Behrendt et al., 1996 and ref. therein). The experiment of the Vest Antarctic Rifft System (Behrendt et al., 1996 and ref. therein). The experiment of the Vest Antarctic Rifft System (Behrendt et al., 1996 and ref. therein). The experiment of the Vest Antarctic Rifft System (Behrendt et al., 1996).

gravity, geomagnetic, radar and wide-angle seismic investigations. The WNW-ESE onshore part of the transect runs from south of Varney Nunatak to far northwest of Brimstone Peak (Mount Joyce quadrangle). The goal of the ACRUP-1 experiment was to study the crustal and subcrustal structures at the transition between the Transantarctic Mountains and the Ross Sea depression. The main results are summarised in Bozzo et al., (1997a, 1997b, 1997c), Della Vedova et al. (1997), Ferraccioli and Bozzo (1999), Pondrelli et al. (1997) and Reitmayr et al. (1997).

SHORT DESCRIPTION OF GEOLOGY The Relief Inlet quadrangle encompasses a Late Cambrian granitic basement, made up by large bodies of the Granite Harbour Igneous Complex. This complex belongs to the Wilson Terrane, the westernmost of the tectonic units which form the Ross Orogen at the Pacific edge of the Transantarctic Mountains. Granodiorites and granites are the prevalent lithologies with minor bodies of diorites and more mafic varieties.

#### LITHOSTRATIGRAPHY

Granite Harbour Igneous Complex During the last fifteen years, some petrographic and geochemical differences with a regional significance have been described for Victoria Land, particularly in the area between Aviator Glacier and the Mountaineer Range. Borg (1984), Borg et al. (1986), and Vetter and Tessensohn (1987) stated that these intrusive rocks, which occur in two NW-SE trending belts throughout the Wilson Terrane, represent the magmatic signature of an active continental margin. The western belt is made up of S-type, peraluminous, two-mica and mainly K-feldspar porphyritic granite; coeval I-type hornblende granodiorite, diorite and tonalite form minor plutons and dykes.

Granite Harbour Granodiorite And Granite (GHgr)

The granitic bodies which occur in this quadrangle belong to the western belt. These rocks form the massifs that crop out at north and south of the David Glacier in the Prince Albert Mountains, Whitmer Peninsula, Lamplugh and Prior Island, Starr and Varney Nunataks. In northern Victoria Land, the Granite Harbour rocks are usually emplaced in the metamorphic rocks of the Wilson Terrane. However, in this quadrangle the metamorphic rocks do not crop out and only at Cape Philippi have been locally recognised some rafts of high grade metamorphic rocks, which can be correlated with the Priestley Schist. Two types of intrusive rocks occur in this area: the Larsen Granodiorite and the Irizar Granite (Gunn and Warren, 1962). The former consists of coarse-grained inequigranular received granodiorite more granited inequigranular modified granodiorite granited inequigranular modified granodiorite granited inequigranular modified granodiorite granited granodiorite granited granodiorite granited granited granodiorite granited granit foliated granodiorite-monzogranite, while the latter is a pink, unfoliated, equigranular medium to coarse-grained syeno-monzogranite. Field relationships indicate that the Irizar Granite is younger than the Larsen Granodiorite, and locally the former is intruded within the latter. An example of these crosscutting relationships is visible at Cape Philippi (Dallai et al., 1998). The areal distribution of the two types indicates that the Larsen Granodiorite is widely diffuse in the most of the outcrops, while the Irizar Granite crops out immediately at north of Cape Philippi and at Cape Irizar. The Larsen Granodiorite shows a foliated fabric defined by shape preferred orientation of K-feldspar megacrysts and mafic enclaves; the latter have strongly elongated shapes parallel to the K-feldspar alignment. This fabric corresponds to a magmatic foliation, well developed in some outcrops south of the David Glacier, at Hughes Bluff, Cape Reynolds and Lamplugh Island (eastern side). North of the David Glacier well foliated Larsen Granodiorite crops out at the spot height 760 and along the western side of the D'Urville Wall. The magmatic foliation shows a main N100°–130°E trend and moderate to steep dips toward south-southwest. However, local variation in strike and dip of foliation have been recognised at the outcrop scale, in particular in the eastern side of Lamplugh Island (N165°E / 70°ENE) and in the eastern side of D'Urville Wall (N30°-60°E / 60°NW).
Some samples of Larsen Granodiorite collected at Tarn Flat (Prince Albert Mountains), close to the north side of Backstairs Passage, yelded a biotite Rb/Sr cooling age of 498 ±11 Ma (Borsi et al., 1987). The Irizar Granite, sampled at Cape Irizar and north of the David Glacier, yelded a whole rock-biotite Rb/Sr emplacement age of 483 ±14 Ma and a biotite Rb/Sr cooling age of ~ 470 Ma (Rocchi et al., 1994). These ages fall in the range of the most of the Granite Harbour plutonites elsewhere. In the Deep Freeze Range, a few kilometres to the north of this quadrangle, emplacement ages range from 530 ±57 Ma (Inexpressible Island Orthogneiss) to 508 ±6 Ma (Mt. Abbott granite) (Armienti et al., 1990) and 484 ±16 for synkinematic leucogranite (Tonarini & Rocchi 1994). Whole rock-biotite cooling ages span from 450 Ma in the Deep Freeze Range to 490 Ma in the Prince Albert Mountains (Tonarini & Rocchi 1994).

Granite Harbour Gabbro and Ultramafite (GHga)

Mafic rocks are diorites and quartz monzodiorites with horneblende and biotite, in places pyroxene-bearing. In this quadrangle these rocks crop out at Varney Nunatak and north of Cape Philippi. Minor bodies and dykes, not mapped for small dimension, occur in a number of outcrops (e.g. at Mount Bellingshausen). In places these rocks show to have been emplaced in the more acidic varieties of the Granite Harbour Igneous Complex. Most of the granitic bodies are cut by dykes, which are widespread at Starr Nunatak and in the whole area of Cape Reynolds. Most of the dykes are subvertical and strike from N5°E to N40°E (see also Kleinschmidt and Matzer, 1992; Stackebrandt and Thiedig, 1992). In some outcrops different generations of dykes with intersecting relationship were observed. Subvertical red-coated dykes proved to be related to the Irizar Granite (Dallai et al., 1998) and in places are cut by black mafic dykes, which are probably related to the McMurdo volcanic rocks. A truly spectacular example of this occurs at the D'Urville Wall, on the northern side of the David Glacier. At Lewandowski Point, a reactivation of the borders of the Irizar-related dykes for the emplacement of McMurdo-related dykes has

No major outcrop occurs in this quadrangle and the presence of McMurdo volcanic rocks is limited to dyke sets, emplaced in the Granite Harbour Intrusive rocks. Examples of this are at the D'Urville Wall, at the southern slope of Mt. Neumayer, and in several granitic bodies.

#### **TECTONICS** Ross Tectonics

In this quadrangle the effects of the Ross tectonic events are not widespread, apart the occurrence itself of the Granite Harbour intrusive rocks which were interpreted as the magmatic signature of a Ross-age continental margin convergence. The most common mesoscopic structure is the magmatic foliation, which characterises most of the intrusions belonging to the Larsen Granodiorite. The occurrence of foliated and unfoliated intrusive bodies testifies that magmatism was coeval and partly postdated the Late Cambrian Ross Orogen deformation.

Minor SW-dipping low angle thrust faults are exposed along the eastern slopes of Mt Stierer-Mt Bellingshausen ridge. We consider these faults to belong to the Ross age tectonics as they dissect the Larsen Granodiorite and are in turn injected by mafic dykes belonging to the Granite Harbour Igneous Complex. Furthermore, these faults have the same size and geometric features than reverse faults along the NE walls of the Mt Larsen, a few kilometres to the N (Mount Melbourne Quadrangle). Other minor structures correspond to NS or NE-SW reverse faults moderately dipping toward W or NW, that crosscut the granitic rocks at Cape Reynolds. These structures are characterised by development of phyllonitic layers of centimetre size in tickness (2-6 cm), down-dip striae and E-SE sense of shear. All the above described fault structures could represent a brittle tectonics that affected the Paleozoic basement at the vanishing state E-SE sense of shéar. All the above described fault structures could represent a brittle tectonics that affected the Paleozoic basement at the vanishing state From a geophysical point of view, the magnetic lineament flanking the eastern side of the Gitara Anomaly Complex (Bozzo et al., 1997d) separates areas featuring contrasting high-frequency anomalies as well as more regional patterns. This NW-SE magnetic lineament crosses the David Glacier in the NE corner of the adjoining Mount Joyce quadrangle, and continues in this quadrangle, roughly parallel to the coast up to Varney Nunatak southwards. It was defined as the "Central Victoria Land Boundary" by Ferraccioli and Bozzo, (1999). This lineament is tentatively interpreted by the same authors to be the unexposed southern continuation of the Exiles Thrust of Ross age, recognized from geological field work and magnetics at the Pacific Coast of North Victoria Land (Flöttmann & Kleinschmidt 1991). Moreover Bosum et al. (1989) and Roland (1991) suggested that this lineament marks the boundary between the Ross

#### Post - Ross Tectonics

The most evident tectonic lineament occurring in the map is represented by a left-lateral fault running at E of Mt Gaberlein. Towards the N this fault strikes N-

Orogen and the East Antarctic shield.

S, and in the adjacent Mount Joyce quadrangle it turns to a NE-SW direction, just south of Mt Bellingshausen, where the fault splits in two branches. We have no data on the age of this structure, however its morphological evidence and brittle feature suggest its pertinence to the recent tectonic evolution of the region. To a larger scale, a prominent feature linked to the post-Ross tectonics is the David Glacier Lineament separating segments of the Transantarctic Mountains characterised by different amount of uplift and direction of the rift shoulder escarpment (Fitzgerald et al., 1986; Fitzgerald, 1992). Mazzarini et al. (1997) interpreted the David Glacier Lineament as a major transfer structure, separating the northern and southern segments of Victoria Land. The data on the distribution of Mesozoic and Cenozoic rocks and of the Kukri Peneplain suggest a smaller amount of rock uplift for the southern segment with respect to the northern Victoria Land segment (Fitzgerald, 1992). The David Glacier Lineament marks also a change in direction (NE-SW in the north to about N-S in the south) of the rift shoulder escarpment of the West Antarctic Rift System (Tessensohn & Warner, 1991), which is locally right-lateral offset by about 10 km. Emplacement of post-Ross E-W dacitic dykes is also connected with a dextral sense of shearing (Stackebrandt and Thiedig, 1992). The age and activity of the David Glacier Lineament is not well constrained; its offshore prolongation affects the acoustic basement only and not the Cenozoic sequences. However, a genetic link for the E-W trending features and the Jurassic magmatism is suggested by Wilson (1995) and Bozzo et al., (1997d), and hence a Mesozoic-Cenozoic reactivation is probable. If this is the case, the David Glacier lineament it may well have influenced the tectonic patterns of the Prince Albert Mountains block during riff/uplift phases occurring along the margin of the East Antarctic Craton in the Mesozoic and Cenozoic. Other field data by Rossetti and Storti (1998) indicate that the Cenozoic tectonic framework is dominated by NW-SE trending right-lateral strike-slip faulting, which is in good agreement with the teatures of the Hoss Sea. The Relief Inlet and the adjoining Mount Joyce quadrangles were the site of the ACRUP-1 (Antarctic Crustal Profile), a geophysical experiment which complements the previous GANOVEX V seismic refraction experiment across the Deep Freeze Range (O'Connell and Stepp, 1993). One of the most interesting results from the onshore part of this experiment is the presence of a 7.7 to 7.8 km/s layer just beneath the interpreted Moho. It is about 20-25 km in depth beneath the coast, and deepens to about 40 km within 50-70 km inland (Mazzarini et al., 1997). This could be a cushion of soft upper mantle material similar to the one detected at the base of the Deep Freeze Range crust (O'Connell and Stepp, 1993). This layer may have a regional extent and be related to the thermal perturbation of the mantle beneath the Transantarctic Mountains. Progressive migration of such a layer beneath the Transantarctic Mountains could be the origin of differential thermal uplift of different crustal blocks (Della Vedova et al., 1997).

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