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Neogene Tectonics in the Edisto and Tucker Inlet Region and Its Correlation with Offshore Magnetic Anomalies North of Cape Adare, Northern Victoria Land, Antarctica

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Abstract: The Southern Ocean region between northern Victoria Land (Antarctica) and Australia is characterized by a dense array of NW–SE trending fracture zones. These fracture zones are apparently parallel to an intraplate dextral strike-slip fault system that cuts through the continental crust of northern Victoria Land and seems to continue into the Ross Sea. In order to evaluate a possible correlation between these off- and onshore tectonic features, a combined aerogeophysical and structural-geological study was performed in the greater Edisto and Tucker Inlet area and in the offshore region north of Cape Adare.

The comparison of onshore brittle faults and the recorded magnetic features Cape Adare indicates a close alignment of these faults with offshore anomalies. Individual faults trend often parallel to the main glaciers suggesting that the course of these glaciers is tectonically controlled. Faults can be separated into a first strike-slip to transtensional dominated group and a second, possibly partially younger extensional one. Based on crosscutting relationships with the Neogene Hallett volcanics, a genetic link between volcanic and tectonic activity is indicated.

The magnetic anomalies in the offshore survey area reveal two main trends that are oriented almost orthogonal to each other. NNW–SSE trending anomalies northeast of Cape Adare represent seafloor spreading in the Adare Trough. Anomalies of the Adare Trough and of the volcanic Adare Peninsula and its northward extension into the Antarctic shelf are parallel to roughly NNW-SSE oriented dextral-transtensional to extensional faults in the onshore region, which possibly facilitated magma extrusion. NE–SW oriented normal faults seem to segment the main bodies of the Hallett Volcanics, which is also visible in the continental (i.e. southwestern) flank of the Adare Trough.

Zusammenfassung: Der Südliche Ozean zwischen dem nördlichen Viktorialand (Antarktis) und Australien ist durch dicht nebeneinander liegende NW–SE streichende intra-ozeanische Bruchzonen gekennzeichnet. Diese Bruchzonen verlaufen etwa parallel zu einem intrakontinentalen dextralen Blattverschiebungsgürtel, der die kontinentale Kruste des nördlichen Viktorialandes durchzieht und sich in das Rossmeer hinein fort zu setzen scheint. Um eine mögliche Korrelation zwischen tektonischen Elementen an Land und im ozeanischen Bereich zu prüfen, wurde daher eine kombinierte aerogeophysikalische und strukturgeologische Studie im weiteren Umfeld des Edisto und Tucker Inlet und im Seebereich nördlich von Cape Adare durchgeführt.

Die strukturelle Analyse von Sprödflächen an Land und die aeromagnetische Befliegung im marinen Bereich deuten auf eine enge Beziehung terrestrischer Störungssysteme und mariner magnetischer Anomalien hin. Viele Störungen verlaufen etwa parallel zu den Hauptgletschern, was vermuten lässt, dass der Verlauf dieser Gletscher tektonisch beeinflusst ist. Es konnten zwei Hauptgruppen von Störungssystemen unterschieden werden. Eine erste Gruppe besteht überwiegend aus Blattverschiebungen und transtensionalen Störungen, eine zweite Gruppe aus vermutlich zumindest teilweise jüngeren Abschiebungen. Aufgrund von Überschneidungskriterien mit den neogenen Hallett Volcanics lassen diese Abschiebungen auf einen genetischen Zusammenhang zwischen vulkanischer und tektonischer Aktivität schließen.

Die magnetischen Anomalien im marinen Bereich verlaufen in zwei fast senkrecht aufeinander stehenden Richtungen. NNW–SSE gerichtete Anomalien nordöstlich von Cape Adare stellen ozeanische Spreizungsmuster im Adare Trough dar. Anomalien des Adare Trough und der vulkanischen Adare Peninsula und ihrer nördlichen Verlängerung auf dem antarktischen Schelf verlaufen parallel zu etwa NNW–SSE gerichteten dextral-transtensionalen bis extensionalen Störungen, die vermutlich die Extrusion der Magmen in diesem Bereich erleichtert haben. NE–SW orientierte Abschiebungen scheinen die Hauptkörper der Hallett Volcanics zu segmentieren, was ebenso auf der kontinentseitigen, südwestlichen Flanke des Adare Trough erkennbar ist.

INTRODUCTION

Northern Victoria Land is located at the intersection between the Pacific transform margin of Antarctica and the Ross Sea. It hosts the Pacific termination of the Transantarctic Mountains (TAM), a high-elevation mountain chain spanning across the Antarctic continent for more than 3000 km (Fig. 1A). The front of this mountain chain forms the uplifted western shoulder of the West Antarctic Rift System (WARS) that evolved in response to the ongoing fragmentation of the Australia – Antarctica – Greater New Zealand segment of Gondwana since the late Mesozoic. The WARS represents one of the world's largest continental rift systems, and defines the tectonic boundary region between East and West Antarctica. It is segmented by numerous transverse and oblique faults and has experienced several phases of uplift and denudation since the Cretaceous with a major phase around 50 Ma (e.g., FITZGERALD 2002). In general, the evolution of the WARS is interpreted to have occurred in two major phases (e.g., SALVINI et al. 1997, SUTHERLAND 1999, VAN DER WATEREN & CLOETING 1999, FITZGERALD 2002, ROSSETTI et al. 2003, 2006), i.e. (i) Late Mesozoic to Early Cenozoic extension to left-lateral transtension during the separation of Antarctica, Australia and Greater New Zealand followed by (ii) a tectonic reorganisation of the Ross Sea region and the reactivation of pre-existing structures by right-lateral to dextral-transtensional shear in the western sector of the WARS from about 50 Ma onwards.

However, the lack of high-resolution structural, stratigraphic and geochronological constraints on the Meso-Cenozoic brittle deformation history hampers a detailed reconstruction of the underlying processes, and results in different and contrasting interpretations of the tectonic evolution of the Ross Sea region. For instance, recent models set the Cenozoic evolution of the East/West Antarctic boundary region into the frame of large-scale right-lateral tectonics and propose a close genetic link between dextral shear and extensional to transtensional tectonics in the Ross Sea (SALVINI et al. 1997). These models, however, fail to explain the apparent left-lateral kinematics required for the separation of Australia/Tasmania from Antarctica in the Late Mesozoic to Early Cenozoic based on several marine geophysical data sets. A further problem is the way in which the onshore segments of northern Victoria Land are involved in the major extension processes affecting the

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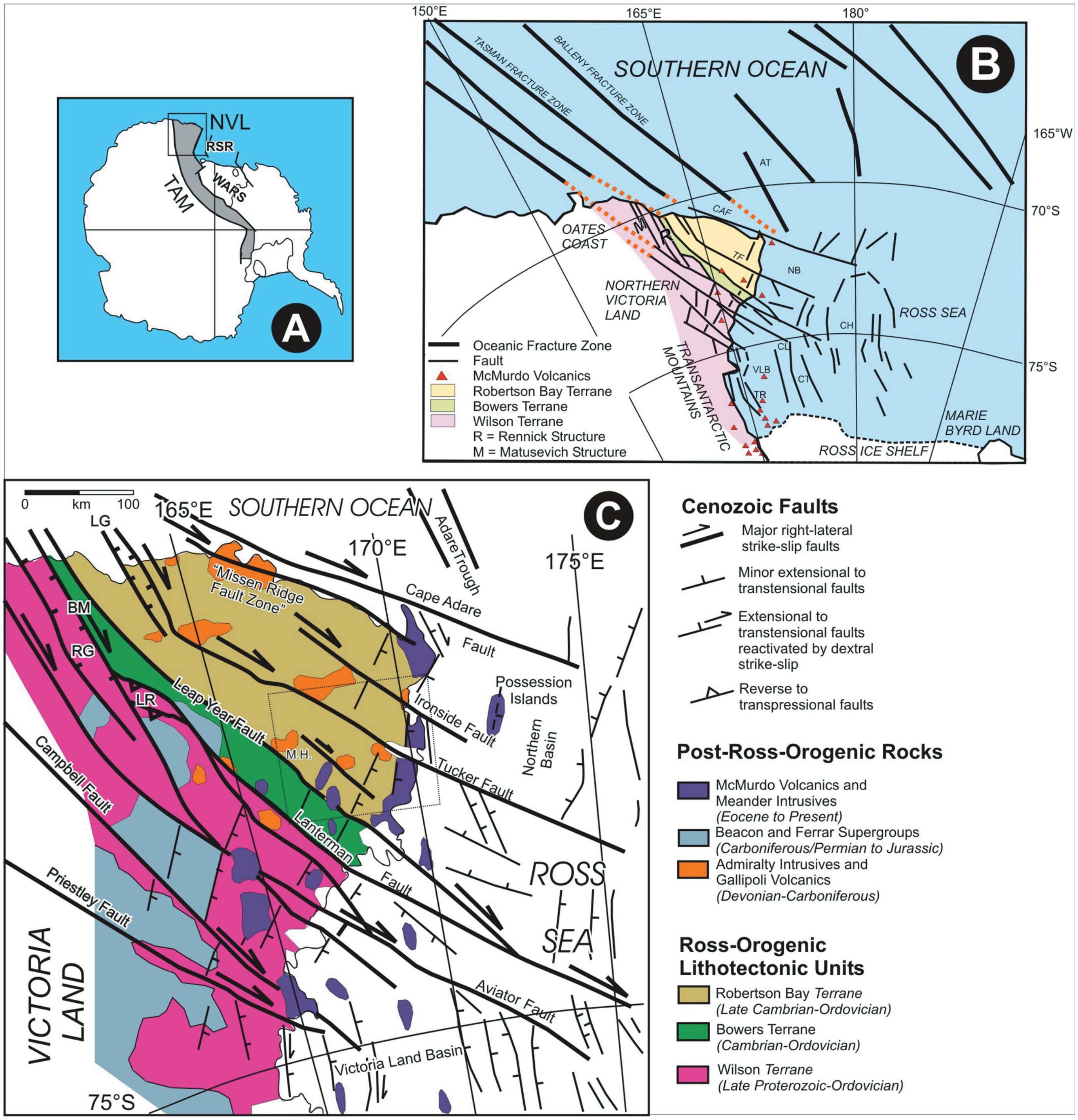

Fig. 1: Overview and details of the working area. (A) Map of Antarctica indicating the Transantarctic Mountains (TAM), northern Victoria Land (NVL), RSR the Ross Sea Rift (RSR), the West Antarctic Rift System (WARS) and the location of the study area shown in Figure 1C.
(B) Tectonic sketch map of the Ross Sea – Transantarctic Mountains region modified after Salvini et al. (1997) showing the main offshore fracture zones between Australia and Antarctica and their possible continuation into northern Victoria Land and the Ross Sea (cf. Storti et al. 2007). AT = Adare Trough, CAF= Cape Adare Fault, TF = Tucker Fault, NB = Northern Basin, CH = Central High, CL = Coulman High, VLB = Victoria Land Basin, TR = Terror Rift, CT = Central Trough.
(C) Tectonic sketch map of northern Victoria Land showing the major Cenozoic right-lateral strike-slip fault systems (modified after Salvini et al. 1997 and Rossetti et al. 2002). The stippled rectangle shows the outlines of the map in Figure 2; M.H. = Mt. Holdsworth.

Abb. 1: Übersicht über die Antarktis und das Arbeitsgebiet. (A) Übersichtskarte von Antarktika mit dem Transantarktischen Gebirge (TAM), der Lage von Nordviktorialand (NVL), dem Rossmeer-Rift (RSR), dem Westantarktischen Riftsystem (WARS) und der Lage des Arbeitsgebietes in Abbildung 1C.
(B) Tektonische Skizze der Region Südlicher Ozean und Rossmeer und Transantarktischem Gebirge verändert nach Salvini et al. (1997) mit den wichtigsten intraozeanischen Bruchzonen zwischen Australien und der Antarktis und deren mögliche Fortsetzung ins Nordviktorialand und das Rossmeer (vgl. Storti et al. 2007). AT = Adare Trough, CAF = Cape Adare Fault, TF = Tucker Fault, NB = Northern Basin, CH = Central High, CL = Coulman High, VLB = Victoria Land Basin, TR = Terror Rift, CT = Central Trough.
(C) Tektonische Übersichtskarte des nördlichen Viktoria-Landes mit den wichtigsten känozoischen rechtslateralen Störungssystemen (verändert nach Salvini et al. 1997 und Rossetti et al. 2002). Das Rechteck zeigt die Lage des Karte in Abbildung 2; M.H. = Mt. Holdsworth.

East/West Antarctic continental crust in the Ross Sea in Cenozoic times and how they relate to offshore tectonic features in the Pacific Southern Ocean and the Ross Sea such as the Adare Trough or the Victoria Land Basin, respectively (Fig. 1C).

Major marine fracture zone arrays in the Pacific sector of the Southern Ocean between Australia and Antarctica (e.g., Tasman or Balleny fracture zones) show a general NW–SE oriented trend and are directed towards the Antarctic continent (Fig. 1). Onshore northern Victoria Land, major Cenozoic fault systems strongly influencing the orientation of the main geomorphological features (e.g. the Matusevich, Rennick, or Lillie glaciers) show very similar trends, as do the main Ross-orogenic tectonic boundaries (KLEINSCHMIDT & TESSENSOHN 1987). Some authors, thus, propose a possible connection between these offshore and onshore features (e.g., SALVINI et al. 1997, LISKER 2002, KLEINSCHMIDT & LÄUFER 2006), although the continuation of such marine tectonic structures into the adjacent continental crust was often questioned in the past. There are, however, prominent examples for such composite structures, e.g. the "Pelusium Line" of NEEV (1977) including the St. Paul – Cape Palmas – Grand Cess fracture zones (BEHRENDT et al. 1974) and Chain Fracture Zone – Benough Trough (BENKHELIL 1982) across the continental margin of West Africa, or the Sonne Fault at the southern coast of Iran and Pakistan (KUKOWSKI et al. 2000, 2001). Furthermore, the model by SALVINI et al. (1997) proposes that Cenozoic apparent left-lateral transform motion in the seismically active intra-ridge segments of the Southeast Indian Ridge is not restricted to the apparent off-sets in the ridge segments themselves but is rather accomodated by a major intraplate right-lateral strike-slip fault system onshore northern Victoria Land and in the Ross Sea (cf. also STORTI et al. 2007). This contradiction of onshore strike-slip kinematics and offshore transform motion has caused many debates and, to date, there is still no satisfying explanation for this rather peculiar and anomalous geodynamic situation.

Marine surveys and satellite data indicate seafloor spreading and fracture zone arrays in the Pacific Southern Ocean between Antarctica and Australia. NW–SE oriented right-lateral fault systems represent the dominating Cenozoic structural features in northern Victoria Land (SALVINI et al. 1997, LÄUFER et al. 2003, ROSSETTI et al. 2003a,b 2006, KLEINSCHMIDT & LÄUFER 2006). Aeromagnetic surveys flown over northern Victoria Land show magnetic features that are aligned with these strike-slip systems and older (i.e., Ross-age) structures (FERRACCIOLI & BOZZO 1999, FERRACCIOLI & BOZZO 2003).

For example, major positive magnetic anomalies can be traced along the eastern margin of the Rennick Glacier (DAMASKE & BOSUM 1993) and over a distance of more than 100 km west of the USARP Mountains along the Matusevich Glacier (DAMASKE & BOSUM 1993, FERRACCIOLI et al. 2003). All major linear magnetic anomalies have the same NW–SE to NNW–SSE directed general trend as the onshore strike-slip to transtensional faults, and can be traced into the off-shore regions of the Antarctic continental shelf. A possible correlation of on- and offshore magnetic anomalies and tectonic elements might thus suggest a direct relation of marine and continental structures as proposed by SALVINI et al. (1997), ROSSETTI et al. (2003b) or KLEINSCHMIDT & LÄUFER (2006).

A prominent tectonic feature in the Southern Pacific Ocean off northern Victoria Land and in the development of the Ross Sea and the West Antarctic Rift System is the oceanic Adare Trough, in which seafloor spreading occurred between 43 and 27 Ma (CANDE et al. 2000). However, the interpretation of some marine anomalies between the Adare Trough and the Adare Peninsula (e.g., C16-18) remains unclear. A link of the southern Adare Trough and the Northern Basin of the Ross Sea Rift has been tentatively suggested by CANDE & STOCK (2006) and DAVEY et al. (2006).

The purpose of this paper is to test the correlation onshore tectonic structures in the greater Edisto and Tucker Inlet area of northern Victoria Land with magnetic features detected during an aeromagnetic survey flown off the Pennell coast towards the Adare Trough. Major questions of this survey were:
(i) whether offshore tectonic features can be traced into the Antarctic continental crust and correlated with onshore large-scale structures;
(ii) whether there are any seafloor spreading anomalies between the south-western termination of the Adare Trough and the Antarctic coast;
(iii) whether this area may be interpreted in terms of stretched continental crust of the Antarctic shelf, and
(iv) whether the Adare Trough is terminated by the postulated roughly coast-parallel Cape Adare Fault offshore northern Victoria Land (SALVINI et al. 1997), or
(v) whether the Adare Trough can be linked to the Northern Basin of the Ross Sea or not. The latter case would not be compatible with the postulated existence of the Cape Adare Fault.

In order to answer these questions, we have applied:
(i) continuous tracing of sedimentological, ductile (folding-related), and brittle to semi-brittle structures,
(ii) orientation and nature of structures, and
(iii) overprinting criteria that have been used to distinguish different events connected with ductile and brittle deformation.
The regional distribution of particularly brittle fault trends were compared to the known major faults in the region and to geomorphological features (such as the course of the main glaciers) as well as offshore features indicated from bathymetric maps and geophysical surveys.

In addition to onshore structural analyses, an aeromagnetic survey was flown over the regions off the Pennell Coast between Yule Bay and Cape Adare and the Adare Trough. The main aim of the aeromagnetic survey was to correlate offshore tectonic elements to large-scale regional structures in onshore northern Victoria Land, and to verify the connection between Adare Trough and the Northern Basin of the Ross Sea as suggested by CANDE & STOCK (2006) and DAVEY et al. (2006). The survey also provides the possibility to trace the Hallett Volcanics of the Adare Peninsula further north beyond Cape Adare. The study is hence of major importance to gain a better understanding of the tectonic evolution of the Ross Sea embayment and its relation to the opening of the Tasman Gateway between Antarctica and Australia.

REGIONAL GEOLOGY AND TECTONIC SETTING

The geologic and tectonic setting of the basement rocks of the northern Victoria Land segment of the Transantarctic Mountains is generally described in terms of three lithotectonic blocks (Fig. 1), which formed due to W-directed subduction of the Palaeo-Pacific Ocean under the active continental margin of Gondwana during the Late Proterozoic to Early Palaeozoic Ross Orogeny (e.g., KLEINSCHMIDT & TESSENSOHN 1987). These units are from W to E the internal Wilson Terrane, the central Bowers Terrane, and the external Robertson Bay Terrane. The Wilson Terrane consists of polyphase metamorphic rocks intruded by the Granite Harbour Intrusives that represents a deeply eroded magmatic arc of Cambro-Ordovician age (e.g. GANOVEX TEAM 1987). The Bowers Terrane is interpreted as a remnant Cambrian oceanic island arc that accreted to the active margin in the Early Palaeozoic (WEAVER et al. 1984). The external Robertson Bay Terrane consists of a thick succession of regularly folded very low-grade to low-grade distal turbidites probably deposited on continental crust (KLEINSCHMIDT 1981). Different scenarios attempt to explain their origin, depending on the direction of subduction, the number of subduction zones, or the question whether the different blocks are allochthonous and thus represent exotic terranes or rather autochthonous units (e.g., BORG & STUMP 1987, KLEINSCHMIDT & TESSENSOHN 1987, ROLAND et al. 2004, FINN et al., 1999, FERRACCIOLI et al. 2002, TESSENSOHN & HENJES-KUNST 2005, FEDERICO et al. 2009). The three main lithotectonic blocks are bound by regional faults (Lanterman and Leap Year faults, Fig. 1C) and are discussed to have been juxtaposed in a transcurrent or convergent mode that possibly was oblique with significant lateral motion (LÄUFER & ROSSETTI 2003, ROCCHI & PNRA2004/4.6 TEAM 2007).

The Ross-orogenic basement is intruded by the Devonian-Carboniferous Admiralty Igneous Complex (BORG et al. 1987) and high-level equivalents (Gallipoli Volcanics). The presence of these volcanics and interbedded lake deposits with plant fossil remains on top of Admiralty plutonic rocks of roughly the same age (e.g. at Mt. Black Prince) indicates a Mid- to Late Palaeozoic phase of considerable uplift (TESSENSOHN 1984, LÄUFER et al. 2006a). This uplift/denudation phase is confirmed by mid-Palaeozoic zircon and titanite fission track ages from the USARP Mountains (LISKER et al. 2006). Whether this uplift phase is related to an orogenic event is, however, still under debate (e.g., CAPPONI et al. 2002).

Furthermore, the Ross-aged basement is unconformably covered by the Late Palaeozoic to Early Mesozoic Beacon Formation (BARRETT et al. 1972) and intruded by the Jurassic Ferrar Dolerites, which mark the onset of Gondwana break-up (GRINDLEY 1963). In southern Victoria Land, the Beacon Supergroup contains also Devonian strata at the base. The Beacon Formation consists of deposits of braided river systems and local freshwater lakes that contain a rich fossil fauna and flora (SCHÖNER et al. 2007). Youngest non-glacial rocks in the area are represented by the Cenozoic alkaline magmatic rocks of the Meander Intrusives and the Malta Peralkaline Silicics, Hallett Volcanics and Melbourne Volcanics of the McMurdo Group (GANOVEX Team 1987).

The tectonic evolution of the Ross Sea region is related to the break-up and continuous fragmentation of the Gondwana supercontinent since the Jurassic. In the early and middle Mesozoic and prior to the break-up of Gondwana, Marie Byrd Land, the Ross Sea region, the Campbell Plateau, the Chatham Rise, the Tasman Rise, the Lord Howe Rise, and New Zealand were adjacent to the Ross Sea margin of West Antarctica (e.g., SUTHERLAND 1995, 1999, 2008, MUKASA & DALZIEL 2000, LUYENDYK et al. 2001). Subduction of the ancient Phoenix plate under the active continental margin of East Gondwana led to collisional tectonics between the Phoenix Plate and Gondwana in mid- to early late Mesozoic times (e.g., LUYENDYK 1995, SMITH 2007). Around 105 Ma, rifting and sea floor spreading commenced between Antarctica and New Zealand and predominately extensional tectonics affected the Ross Sea region. When the spreading centre between the Phoenix and the Pacific plates reached the subduction zone and sea floor spreading was terminated along the West Antarctic – New Zealand – Australia margin, large-scale extensional tectonics affected the boundary region between East and West Antarctica around 95 Ma, which is generally interpreted to mark the onset of the formation of the WARS (e.g., LUYENDYK 1995, LUYENDYK et al. 2001, SIDDOWAY 2008). The Ross Sea is generally divided in four main N–S oriented, asymmetric, up to 175 km wide and at least 8 km deep rift basins (the Victoria Land Basin, the Northern Basin, the Central Trough, and the Eastern Basin; Fig. 1C) separated by internally faulted structural highs that, in turn, represent former graben structures of earlier West Antarctic rift stages (e.g., TESSENSOHN & WÖRNER 1991). The four main basins contain thick piles of volcanics and of sediments mainly derived from the Transantarctic Mountains, which represent the uplifted western shoulder of the WARS.

STRUCTURAL GEOLOGY

The Edisto and Tucker Inlet area

Edisto Inlet and the attributing Edisto Glacier are located along the northwestern side of Hallett Peninsula in the northern Ross Sea (Fig. 2). Both trend mainly NE–SW, with the exception of the upper part of Edisto Glacier that shows a NW–SE directed orientation parallel to Tucker Glacier, the largest glacier in the area that feeds the NW–SE trending Tucker Inlet between Hallett and Daniel Peninsulas. The study area in the greater Edisto and Tucker Inlet region mainly covered the southeastern parts of Admiralty and Victory mountains and northward along the Ross Sea coast up to Moubray Bay. The southeastern border is formed by the volcanic Hallett and Daniell peninsulas.

Main lithologies in the region are low- to very low-grade metamorphic clastic sequences of the Robertson Bay turbidites that are intruded by large granitic bodies of the mid-Palaeozoic Admiralty plutonites. Hallett Peninsula, Daniell Peninsula, and the Malta Plateau are formed by Cenozoic volcanics of the McMurdo Group and Meander Intrusives (GANOVEX TEAM 1987). Dykes of these two groups are found at several locations throughout the area.

Main structural features are open folds and thrusts in the Robertson Bay clastic rocks, which formed during the Early Palaeozoic Ross orogeny (e.g., KLEINSCHMIDT 1981, KLEINSCHMIDT & TESSENSOHN 1987, LÄUFER et al. 2006a). Extensional faults of the Ross Sea rifting event and large-scale faults mainly paralleling the course of the NW–SE oriented major glaciers such as Tucker and Ironside glaciers are part of the Cenozoic intraplate dextral strike-slip belt; both represent the main features influencing the present structural architecture and geomorphology of the region.

The geomorphology of the greater Edisto and Tucker Inlet region is characterized by high-Alpine coastal ranges contrasting with high-elevated inland plateaus to the W, and deep, structurally defined glacial troughs. The main bodies of the Cenozoic magmatic rocks locally form plateau-like bodies, e.g. the Malta Plateau and the top of Hallett and Daniell Peninsula. The latter partially resemble the ancient volcanic morphology with remnants of the former crater and calderas, particularly visible at Daniell Peninsula.

Methodology

Structural analysis in the Edisto and Tucker Inlet area was primarily carried out in order to define deformation within brittle to semi-brittle fault zones. In addition, pre-existing (i.e. Ross-orogenic) structures are investigated by standard structural analysis (e.g., RAMSAY & HUBER 1983, 1987) to distinguish older from younger deformation events. Fault-slip data were documented in all rock types (e.g., Robertson Bay Turbidites, Admiralty Granites, Hallett Volcanics). The relative fault movements was deduced from kinematic indicators, such as mineral fibre steps, Riedel shears, brittle SC-structures, etc. (e.g., PETIT 1987). Additional information of fault kinematics was derived from the analysis of cogenetic structures, e.g. foliation planes, folds, or tension gashes. Separation of inhomogeneous into homogeneous data sets was done with the aid of graphical and mathematical methods. For further informa-

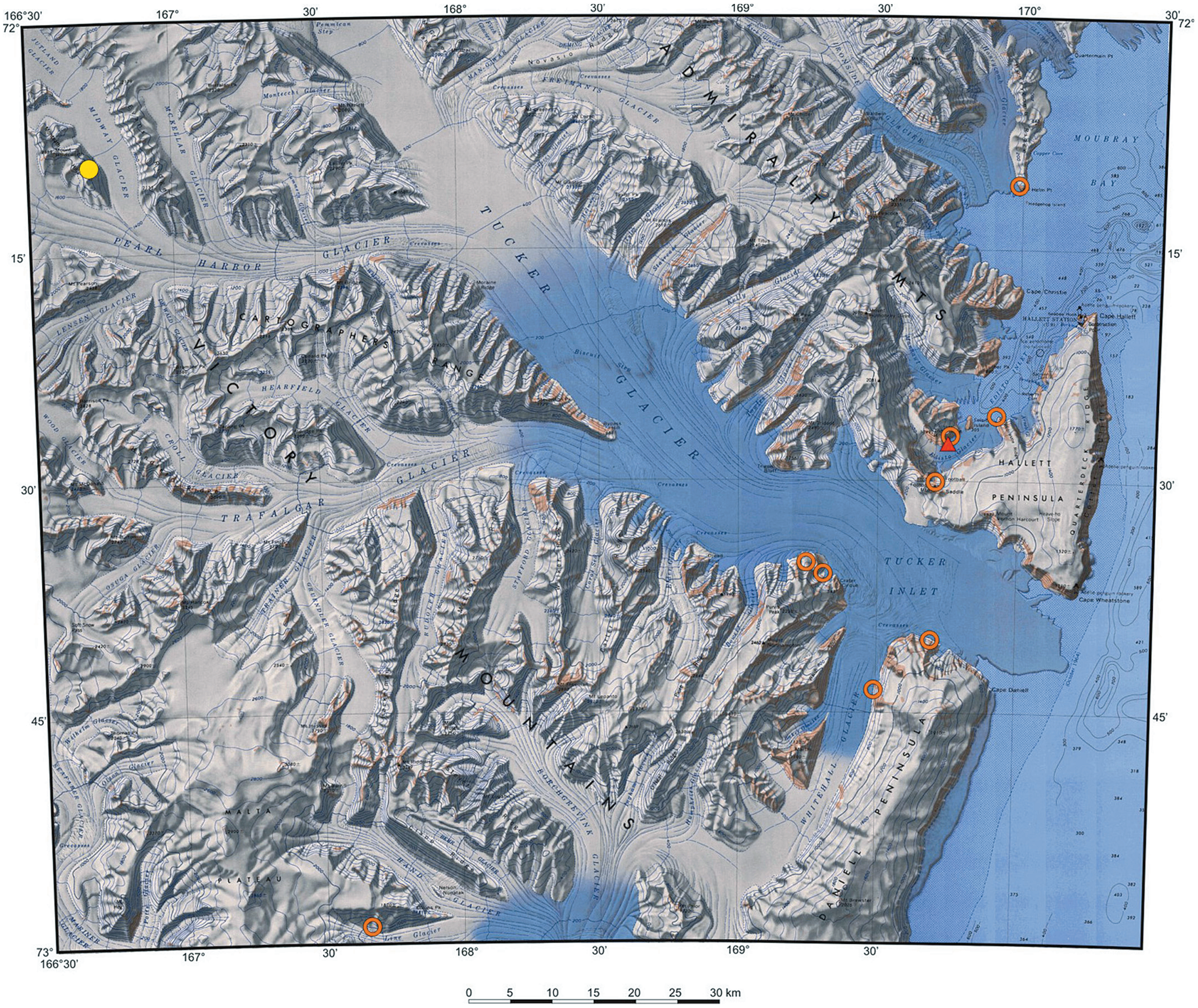

Fig. 2: Map of the Edisto and Tucker Inlet region showing main topographic and geomorphological features and outline of the study area, based on the USGS 1 : 250000 map sheet "Cape Hallett". The locations for fault-slip analyses are indicated (orange circles), for GPS data see Tab. 1. The location of Figure 6 is given as yellow dot. Red triangle = Edisto Glacier base camp.

Abb. 2: Karte der Arbeitsregion um das Edisto und Tucker Inlet mit den wichtigsten topographischen und geomorphologischen Merkmalen (Kartenbasis: USGS Topgraphic Map Series 1:250000 "Cape Halett"). Die Lage der Aufschlüsse für die Störungsflächenanalyse sind als orangefarbene Kreise eingetragen (GPS Daten siehe Tab. 1). Der gelbe Punkt zeigt die Lage der Abbildung 6. Rotes Dreieck = Basislager auf dem Edisto Glacier.

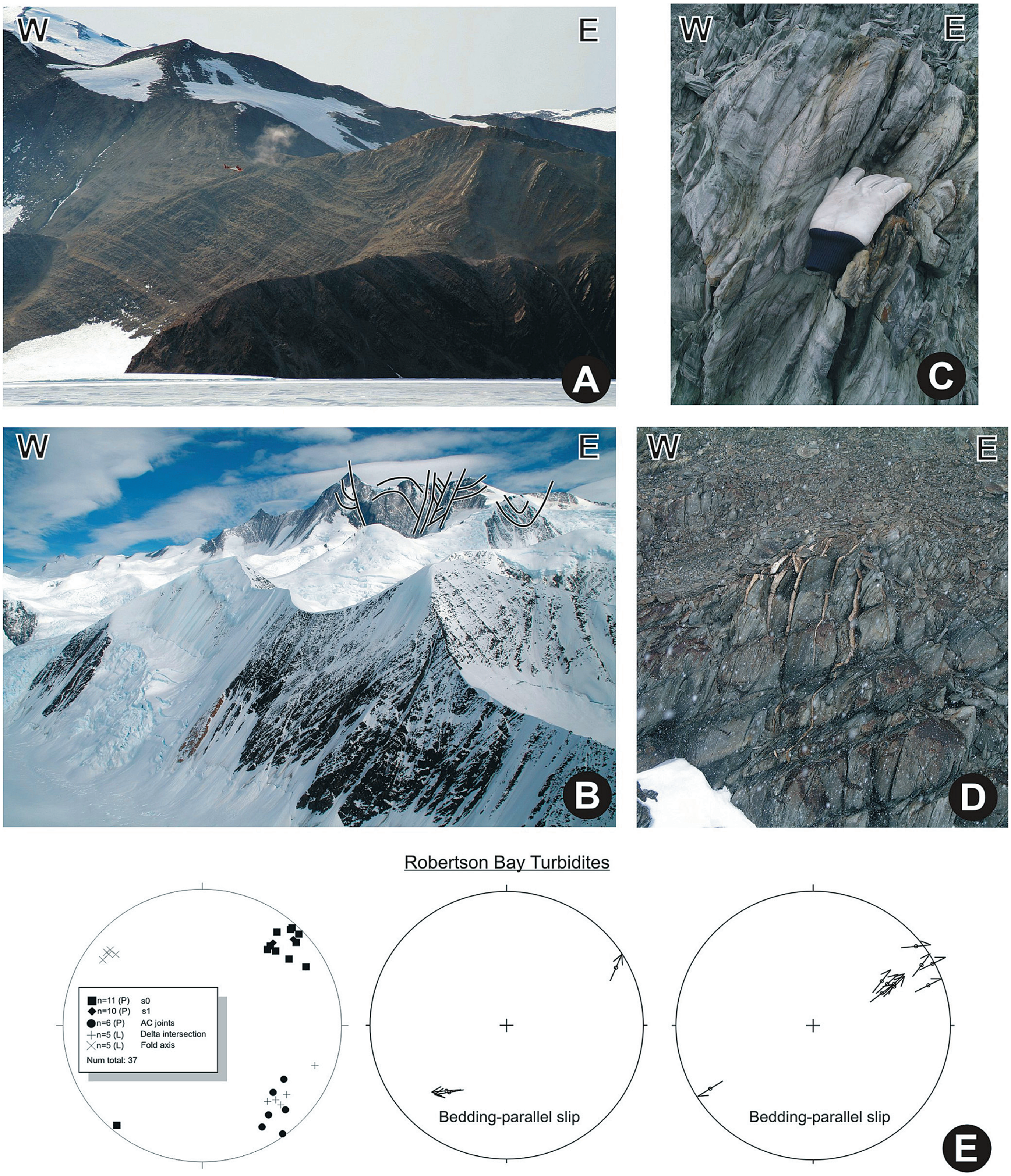

Fig. 3: (A) and (B): Field examples of Ross-age large-scale open folds and faults in turbidites of the Robertson Bay Terrane. (A) = along the northern margin of Edisto Inlet; (B) = synclinal-anticlinal system in the southern face of Mt. Herschel. (C) and (D) = Robertson Bay turbidites showing bedding S0 and cleavage S1 at Edisto Glacier base camp. (E) = Equal area stereoplots (lower hemisphere) of bedding and tectonic elements (left) and fault-slip data related to bedding-parallel slip in Robertson Bay turbidites from Edisto Glacier (centre) and Inferno Peak (right) (located close to M.H. in Fig. 1C). Fault-slip data are shown as Hoeppener diagrams (fault planes as poles, striae as arrows) for better comparison to the plot of bedding etc. on the left-hand side.

Abb. 3: (A) und (B): Geländebeispiele für ross-orogenetische, großdimensionale Falten und Störungen in Turbiditen des Robertson Bay Terranes. (A) = entlang des Nordrandes des Edisto Inlet. (B) = Synklinal-Antiklinal-Struktur in der Südwand von Mt. Herschel. (C) und (D) = Robertson Bay Turbidite mit Schichtung S0 und Schieferung S1 in der Nähe des Edisto Gletscher Basislagers. (E) = Darstellung von Schichtung und tektonischen Elementen (links) und Störungsflächendaten schichtparalleler Gleitungen (Mitte, rechts) in Robertson Bay Turbidtiten entlang des Edisto Glacier (Mitte) und am Inferno Peak (rechts) nahe “M.H.” in Abb. 1C. Störungsflächendaten sind zur besseren Vergleichbarkeit mit den links gezeigten Schichtflächen etc. nach der Methode von HOEPPENER (1955) dargestellt, d.h. Flächen als Polpunkte und Striemungen als Pfeile.

tion on the method of fault-slip analysis and some critical remarks, the reader is referred to the literature (e.g., Decker et al. 1993, Sperner et al. 1993, Meschede 1994, Ratschbacher et al. 1994, Läufer 1996).

Large-scale folds and related structures

Structural analysis of possible Ross-age deformation was performed in the Edisto and Tucker Inlet area and in adjacent areas further northwest. Ross-age rocks are predominantly distal turbidites of the Robertson Bay Formation with mainly silt- and mudstones and minor greywackes. Along the northern margin of Edisto Glacier, these usually dark-greyish clastic rocks contain a 10-20 m thick succession of green feldspar-rich greywackes interlayering with tuffitic silt- and mudstones, which point to a basic volcanic source area in the hinterland of the turbidites. This succession is crosscut by a thick doleritic dyke of unknown age, which intruded into the axial planar S1-cleavage of the folded sequence.

The Robertson Bay Formation in the study area is generally deformed into large open folds with an axial planar cleavage (S1) and fold axes generally oriented NW–SE and dipping gently towards the NW or SE (Fig. 3). Examples of large-scale folds are visible along Edisto Inlet (Fig. 3A), and the prominent peak of Mt. Herschel (Fig. 3B) is formed by a large, slightly east- to northeast vergent anticline with an adjacent syncline and another anticline on its eastern side; the folds are dismembered by steep reverse faults.

Bedding-parallel slip on these folds is shown by slickenlines coated with quartz fibres that sometimes contain chloritic material, which is indicative of up to low-grade conditions during folding (Fig. 3E). Folds and kinematic indicators on these slickenlines prove NE-SW oriented contraction. A general NE directed tectonic transport is supported by a slight north-easterly tilt of the axial plane of the folds and reversely off-set quartz veins within S1. W to SW directed backthrusts and E- to NE directed thrusts visible in large fold structures along Edisto Inlet formed cogenetically to folding and fit into the general E–W to NE–SW directed contractional scenario.

Brittle extensional to strike-slip faulting

Structural mapping of brittle faults reveals the presence of steeply dipping fault arrays that can be grouped into two major sets. These are oriented roughly perpendicular to each other and parallel to the main glaciers (Figs. 4 and 5, Tab. 1. Thus, the course of these glaciers is very likely influenced by the tectonic architecture of the region (Läufer et al. 2006a, Damaske et al. 2007).

The first set of brittle faults consists of NW–SE oriented major and NNW–SSE oriented splay faults that show right-lateral slip and parallel the larger glaciers in the area (e.g., Tucker Glacier, Ironside Glacier: plots RBT 2312, AI 27122s2, Hallett Volc 1912, AI & Hallet V. 26124, AI 14121, AI 26122, AI 20128 in Fig. 4 and Tab. 1). Subordinate conjugate left-lateral faults are oriented NE–SW to ENE–WSW (e.g., parallel to Whitehall Glacier: plot AI 26122). At Mt. Northampton (plots AI 26122 and AI 14121 in Fig. 4 and Tab. 1), dextral faulting parallel to the southern margin of the Tucker Glacier is responsible for strong NW–SE oriented fracture cleavage within the Admiralty Granites. Similar fracture cleavages were observed along dextral faults within Hallett Volcanics at Red Castle Rock at the southern margin of Edisto Inlet (Fig. 5E, plot Hallett Volc 1912 in Fig. 4 and Tab. 1). Dykes of Hallett Volcanics intrude in these faults, but occasionally show indications of dextral faulting, such as slickenlines or off-sets (Fig. 5G). Hence, tectonic movements and volcanic activities were roughly contemporaneous. A major fissure that is likely bound to a NNW–SSE to N–S oriented dextral-transtensional to extensional fault could be responsible for the presence of the dyke-like volcanic rocks forming the Adare Peninsula, which border the study area towards the north (cf. Jordan 1981). Along Honeycomb Ridge at the northern margin of Edisto Inlet (plot AI 27122s2 in Fig. 4 and Tab. 1), NW-SE oriented dextral faults in the prolongation of the Ironside Fault show beautiful examples of flower structure-like arrays which are indicative of local transpression along these faults. Other examples of steep thrusts probably genetically linked to young strike-slip faulting are visible at several localities along the northern margin of the lower Tucker Glacier.

A second and possibly partly younger group of faults shows general NW–SE to NE–SW oriented strike and extensional kinematics (Fig. 5A-C, plots Hallett Volc 15121, Hallett Volc. 15122, Hallett Volc. 1912, AI 27122s2 in Fig. 4 and Tab. 1). NNE-SSW oriented extension fractures and veins most likely belong to this fault system. The NE–SW faults are oriented roughly parallel to the Ross Sea coast and cross-cut Hallett volcanic rocks, wheras at other localities the faults are intruded by these volcanics, for example along Dugdale and Murray glaciers. This indicates that fault activity was contemporaneous with or has outlasted Hallett volcanism. NE–SW oriented extensional faults probably also control the south-eastern border of the Adare Peninsula. The small volcanic Possession Islands located offshore between Cape Hallett and the Adare Peninsula follow a similarly oriented line that could coincide with a normal fault belonging to this fault group.

AI 20128	east. Malta Plateau, Line Glacier	c. 72°58.401'S 167°40.361'E
AI 26122	Mt. Northampton, Tucker Glacier, Victory Mountains	72°35.480'S 169°16.736'E
AI & Hallett Volc. 26124	Football Saddle	72°30.405'S 169°42.805'E
AI 27122s2	Edisto Inlet, Helm Point, Honeycomb Ridge	72°10.711'S 170° 0.223'E
Hallett Volc. 1912	Edisto Inlet, Red Castle Rock	72°26.458'S 169°55.917'E
Hallett Volc. 15122	Tucker Inlet, Daniell Peninsula	72°40.296'S 169°42.950'E
Hallett Volc. 15121	Whitehall Glacier, Daniell Peninsula	72°43.112'S 169°29.729'E
AI 14121	Mt. Northampton, Tucker Glacier, Victory Mountains	72°37.983'E 169°21.258'E
RBT 2312	Edisto Glacier, Base Camp	72°27.172'S 169°44.861'E

Tab. 1: GPS locations of fault-slip data shown in the stereoplots of Figure 4.

Tab. 1: GPS-Lokationen der Störungsflächendaten in den stereographischen Projektionen in Abbildung 4.

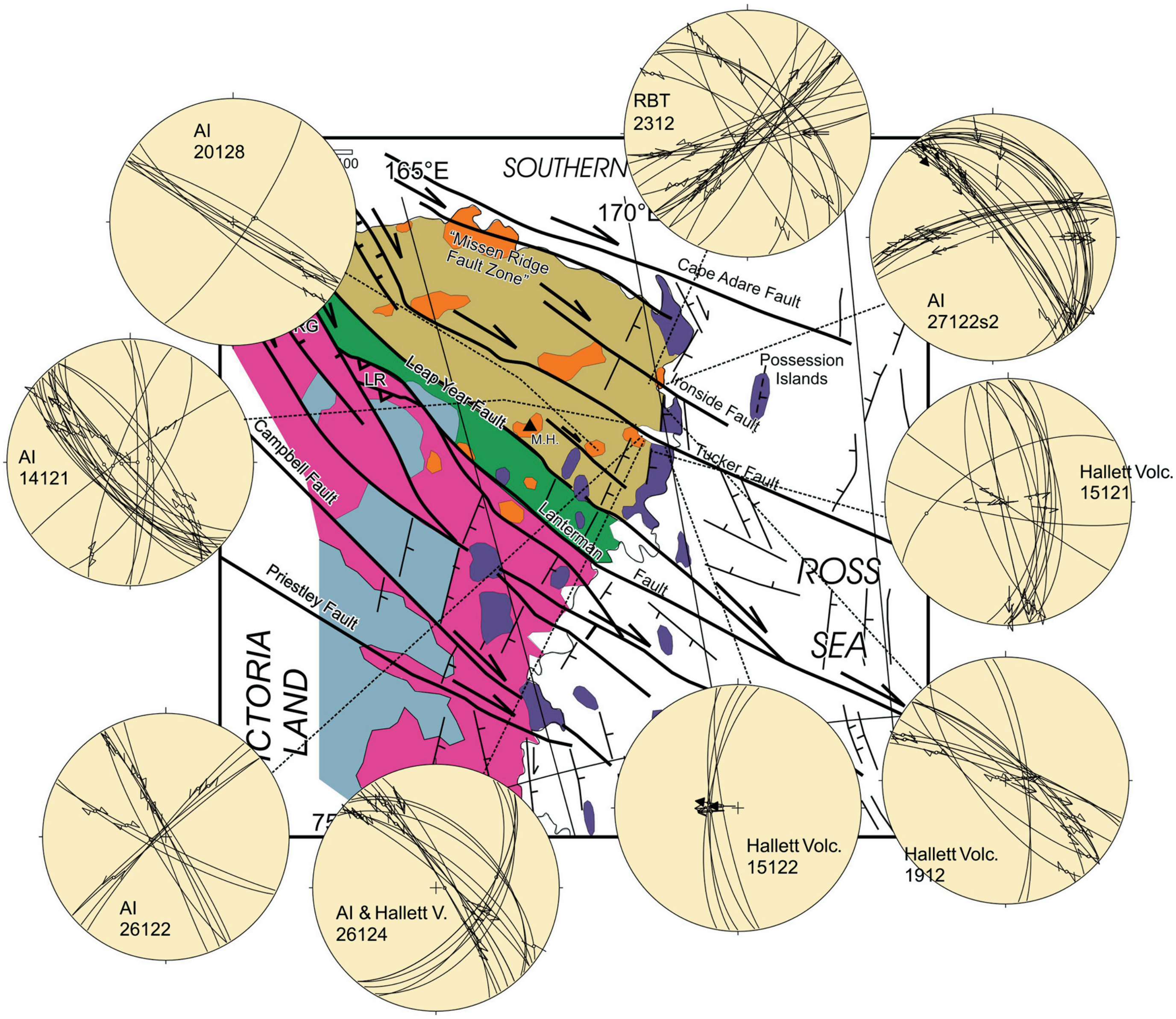

Fig. 4: Cumulative fault-slip data sets of the study area shown as stereoplots (equal-area projections, lower hemisphere). The plots are representative of meso- to microscale faults (given as great circles, striae as arrows) along the main brittle to semi-brittle fault segments. Locations of the plots are listed in Table 1. M.H. = Mt. Holdsworth.

Abb. 4: Störungsflächendaten aus dem Arbeitsgebiet dargestellt im Schmidtschen Netz. Die stereographischen Projektionen sind repräsentativ für meso- bis kleindimensionale Störungen (Flächen als Großkreise, Striemungen als Pfeile) im Bereich der wichtigsten spröden bis semisproden Störungssegmente. Die Lage der stereographischen Projektionen ist in Tabelle 1 aufgelistet. M.H. = Mt. Holdsworth.

Structures of uncertain age

A structural survey was done at Mt. Holdsworth located in the eastern part of Monteath Hills, Victory Mountains ("M.H." in Fig. 1C). Mapped as mid-Palaeozoic Admiralty Granites (GANOVEX Team 1987), the granites outcropping on top of Mt. Holdsworth show a rather porphyritic appearance. They must be regarded as very high-level intrusions of rather subvolcanic than plutonic type. The flanks of Mt. Holdsworth show a dense network of conjugate fractures and faults with several tens of metres of off-set (Fig. 6). These off-sets fit into the picture of gently to moderately dipping reverse faults with splay faults in the footwall block that are dipping in the opposite direction and have also an opposite, i.e. down-dip, sense of shear. The faults show duplex structure arrays in the interfault zones, which are indicative of either reverse or down-dip motion. Flat-lying cooling joints, magmatic foliations, or original stratifications in the top areas of the porphyritic granites and subvolcanic bodies of Mt. Holdsworth, however, indicate that there was not much of rotation around a subhorizontal axis. Thus, significant rotation of these faults can be excluded. Rare fault-slip data collected in this area also indicate low- to moderate-angle faults with reverse sense of shear due to roughly E–W directed contraction.

AEROMAGNETIC SURVEY

The platform utilised for the survey was a De Havilland DHC-6-300 Twin Otter of Kenn Borek Air Ltd., Canada, with a

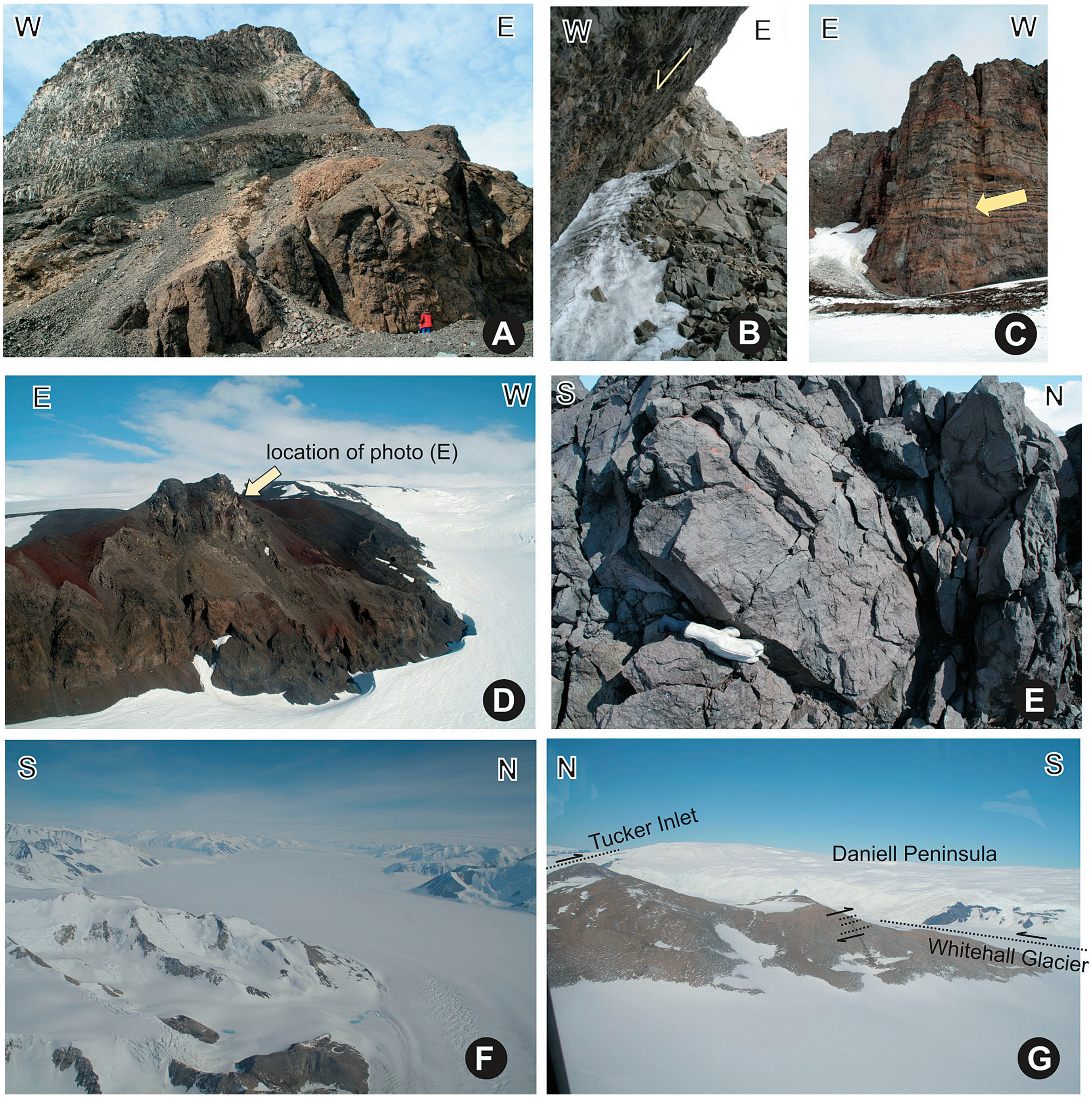

Fig. 5: Field examples of faults in the study area. (A) and (B) = Hallett Volcanics of Daniell Peninsula along southern margin of Whitehall Glacier; (B) shows a N–S striking normal fault at outcrop (A). Fault-slip data from this outcrop are shown in plot "Hallett Volc. 15121" in Figure 4. (C) = N–S striking normal fault in Hallett Volcanics of northern Daniell Peninsula at Tucker Inlet (arrow!). The fault apparently does not continue into the upper portion of the cliff and is very likely syn-magmatic. See plot "Hallett Volc. 15122" in Figure 4. (D) = Hallett Volcanics at Red Castle Rock, Edisto Inlet. (E) = NW–SE striking right-lateral fault plane in Hallett Volcanics of Red Castle Rock, location is indicated in photo (D); the fault set is shown as plot "Hallett Volc. 1912" in Figure 4. (F) = Tucker Glacier, view from Tucker Inlet towards northwest. The glacier follows a major NW–SE striking right-lateral fault. Plots along Tucker Glacier are "AI 14121", "AI 26122", and "AI & Hallett Volc. 26124" in Figure. 4. (G) = View across Whitehall Glacier, which follows a left-lateral fault conjugate to the right-lateral Tucker Fault indicated in Tucker Inlet. Note the dextral offsets of a volcanic dyke within Ross-orogenic basement rocks paralleling the trend of the Tucker Fault.

Abb. 5: Geländebeispiele für Störungen aus dem Arbeitsgebiet. (A) und (B) = Hallett Volcnics der Daniell Peninsula entlang des Südrandes des Whithall Glacier; (B) zeigt eine N–S streichende Abschiebung vom Aufschluss (A). Störungsflächendaten dieses Aufschlusses sind als Projektion "Hallett Volc. 15121" in Abbildung 4 dargestellt. (C) = N–S streichende Abschiebung in Hallett Volcanics der nördlichen Daniell Peninsula am Tucker Inlet (Pfeil!). Die Störung reicht offenbar nicht bis in den oberen Teil der Aufschlusswand und ist sehr wahrscheinlich syn-magmatisch angelegt. Siehe Projektion "Hallett Volc 15122" in Abbildung 4. (D) = Hallett Volcanics von Red Castle Rock, Edisto Inlet. (E) = NW–SE streichende rechtslaterale Störungsfläche in Hallett Volcanics von Red Castle Rock. Die Lage ist in Foto (D) gezeigt, die entsprechenden Daten als Projektion "Hallett Volc. 1912" in Abbildung 4. (F) = Tucker Glacier, Blick vom Tucker Inlet nach NW. Der Gletscher folgt einer bedeutenden NW–SE streichenden Rechtsseitenverschiebung. Projektionen entlang des Tucker Glacier sind "AI 14121", "AI 26122" und "AI & Hallett Volc. 26124" in Abbildung 4. (G) = Blick über den Whitehall Glacier, der einer linkslateralen Störung folgt, welche konjugiert zur rechtslateralen Tucker-Störung angelegt ist. Man beachte die dextralen Versätze eines vulkanischen Ganges im ross-orogenetischen Grundgebirges, die etwa parallel zur Tucker-Störung verlaufen.

Fig. 6: Structures of uncertain age in high-level Admiralty Intrusives SE of Mt. Holdsworth/ Monteath Hills. The maximum age is given by the Late Devonian to Early Carboniferous age of the magmatic rocks. E is to the right. The location is given in Figure 2 as yellow dot.

Fig. 6: Strukturen unsicheren Alters in hochkrustalen Admiralty Intrusives südöstlich von Mt. Holdsworth/ Monteath Hills. Das Maximalalter ist durch das spätdevonische bis frükarbonische Alter der Magmatite belegt. Osten ist rechts. Die Lokation ist als gelber Punkt in Abbildung 2 angegeben.

Scintrex CS-2 magnometer mounted in a towed bird assembly. An average distance of 1-4 km to magnetic sources was assumed, except for areas close to the coast where volcanic rocks crop out at the surface. A constant height of 600 m a.s.l. (with the exception of some smaller coastal areas where flights were performed in draped mode) and a line spacing of 5 km was used to meet the criteria outlined by Bosum (1981), to identify deeper-seated crustal structures with long wavelengths, and to provide information on high frequency anomaly sources at shallower crustal levels. Tie-lines of 25 km width were used to account for the unusually high magnetic diurnal effects at high latitudes. Measurements were made at 10 Hz, which corresponds to a ground level interval of 6-9 m, depending on the speed of the aircraft. The survey covered an area of roughly 100,000 km^2, and a total of 25,665 km were flown (Fig. 7).

Magnetic diurnal variations were continuously measured at Edisto Glacier base camp during the whole survey. The diurnal data sampled at 1 minute intervals were low-pass filtered over 30 minutes to remove the very high frequency signal because of the large distance between base station and survey area and the high level of diurnal activity in Antarctica. These filtered data were subtracted from the corresponding airborne magnetic readings. A correction for regional effects of the earth's magnetic field was performed by calculating the International Geomagnetic Reference Field (IGRF) value at all survey points and at the survey altitude of 600 m. The IGRF value was calculated using IGRF model 2005 at a mean date (12 December 2005) for all flights. After removal of diurnal variations and IGRF reduction, discrepancies between magnetic field values at the intersections of profile and tie lines remained. The calculated deviations were minimized using an iterative levelling approach, so that not only the higher-frequency parts of diurnal variations were accounted for, but also discrepancies due to differences in elevation were reduced. To account for obvious non-geological noise along the profile lines the data were microlevelled (Ferraccioli et al. 1998).

Most magnetic anomalies in the survey area show two almost perpendicular main trends. Distinct NNW–SSE oriented parallel anomalies of positive and negative amplitude represent the ocean-floor spreading pattern of the Adare Trough. In the northern survey area, ocean floor anomalies are oriented perpendicular or at a high angle to the Adare Trough. Towards the Antarctic continent, they seem to terminate close to the continental shelf break (B in Fig. 8) where small-scale anomalies occur. These anomalies probably represent volcanic rocks located relatively close to the surface on the continental shelf.

The Neogene Hallett Volcanics form a chain of high frequency, high amplitude magnetic anomalies between Daniell Peninsula and Cape Adare (H in Fig. 8). The magnetic data indicate that only about half of the volcanic rocks crop out and form the Daniell, Hallett, and Adare peninsulas; the rest is covered by the Ross Sea and seems also to extend further towards NNW for at least 130 km. The volcanic rocks can thus be traced across the continental shelf and slope into the deep oceanic areas.

The Hallett Volcanics forming the Adare Peninsula and their sea-covered continuation trend parallel to the anomalies of the Adare Trough. These anomalies seem to bend towards SSW at about 72 °S, as does the magnetic cluster chain with the less apparent, but clearly distinguishable, continuation in Moubrae Bay. Within the Hallett magnetic anomaly cluster further to the south, the anomalies change their direction again to a general trend parallel to the inferred continuation of the western flank of the Adare Trough (W in Fig. 8). Our data do, however, not testify whether the Adare Trough's spreading anomalies are really curved. South of 72 °S, the distinct spreading pattern becomes less clear, with round-shaped, large anomalies (M in Fig. 8) of high positive amplitude being characteristic in this area. Also the expression of the central Adare Trough anomalies C becomes less clear. Unfortunately, some lines in the east, which would have been crucial for investigating the continuation of the Adare Trough into the Northern Basin, could not be surveyed. The round-shaped anomalies M point to deep extended sources that may be of the same type as the anomalies found on the Malta Plateau, at Greene Point and in the Mt. Melbourne region (Bosum et al. 1989, Ferraccioli et al. 2000).

In the southernmost section of the survey area, two large elongated anomalies P (Fig. 8) terminate the speculative extension of the western flank anomaly of the Adare Trough. They have roughly the same orientation as the older set of the ocean-floor spreading anomalies in the north and are very similar in shape to the Polar-3-anomaly and associated anomalies of the "Southern Cross magnetic unit" (Bosum et al. 1989) and may thus be of the same origin. Furthermore, the high resolution of our survey allows the identification of a clear segmentation within the otherwise rather continuous anomaly pattern of the Adare Trough. The anomaly sequences on either side of the central anomaly of the trough have also very similar amplitude variations with breaks along strike at corresponding positions.

In the offshore region, a roughly NW–SE trending and broad positive magnetic anomaly G (Fig. 8) can be traced into the remarkably straight and sharp continental edge off Cape Adare as indicated on the bathymetric map of the region shown in Figure 7. This anomaly presumably follows a tectonic line or a

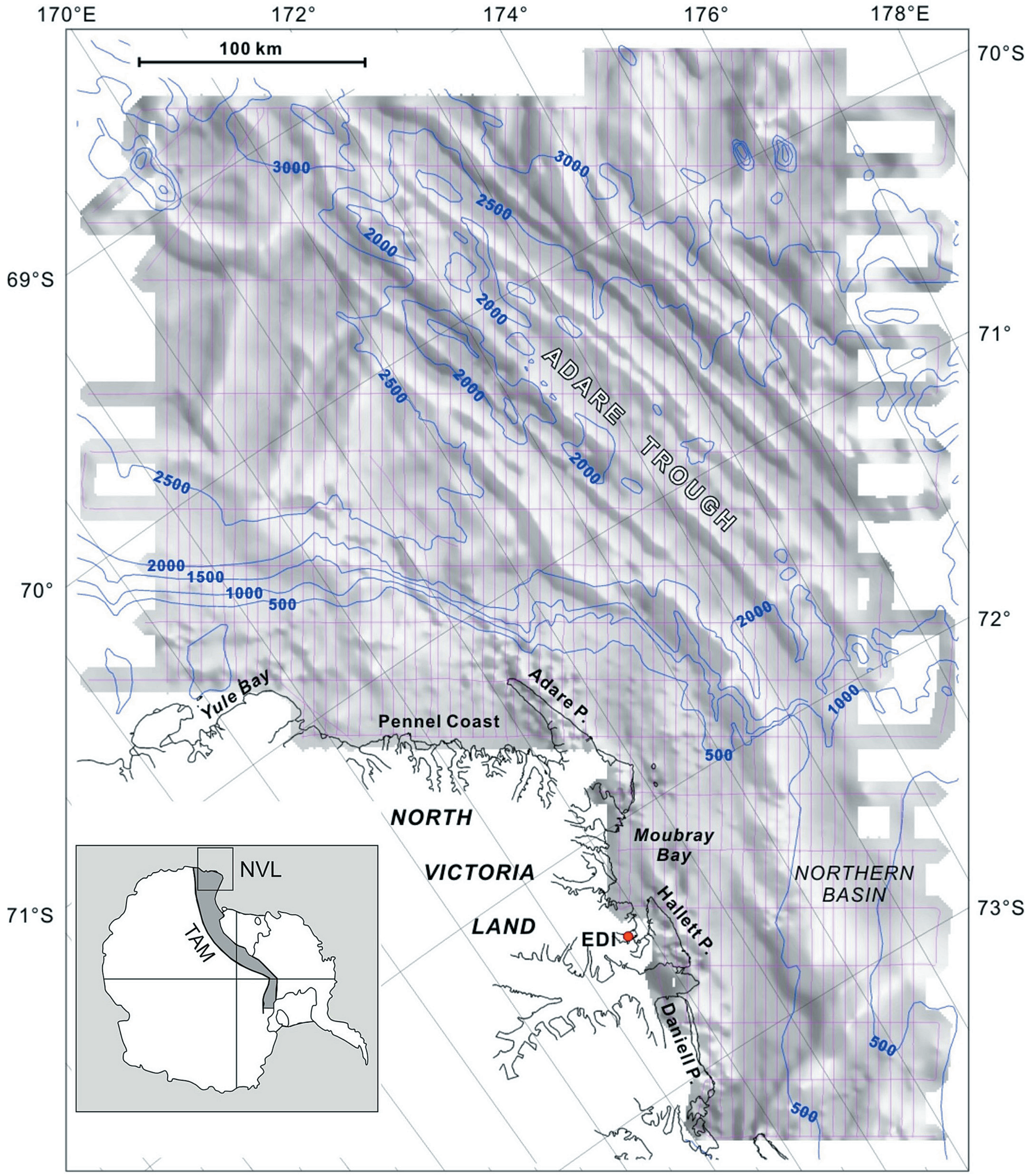

Fig. 7: Flight line track (in red) and bathymetry (taken from GEBCO-97 Digital Atlas, in blue) superimposed on the anomaly map of Figure 8 (in grey shading).

Abb. 7: Fluglinien (in rot) und Bathymetrie (nach GEBCO-97 Digital Atlas, in blau), über die in grau schraffierte Anomaliekarte der Abbildung 8 gelegt.

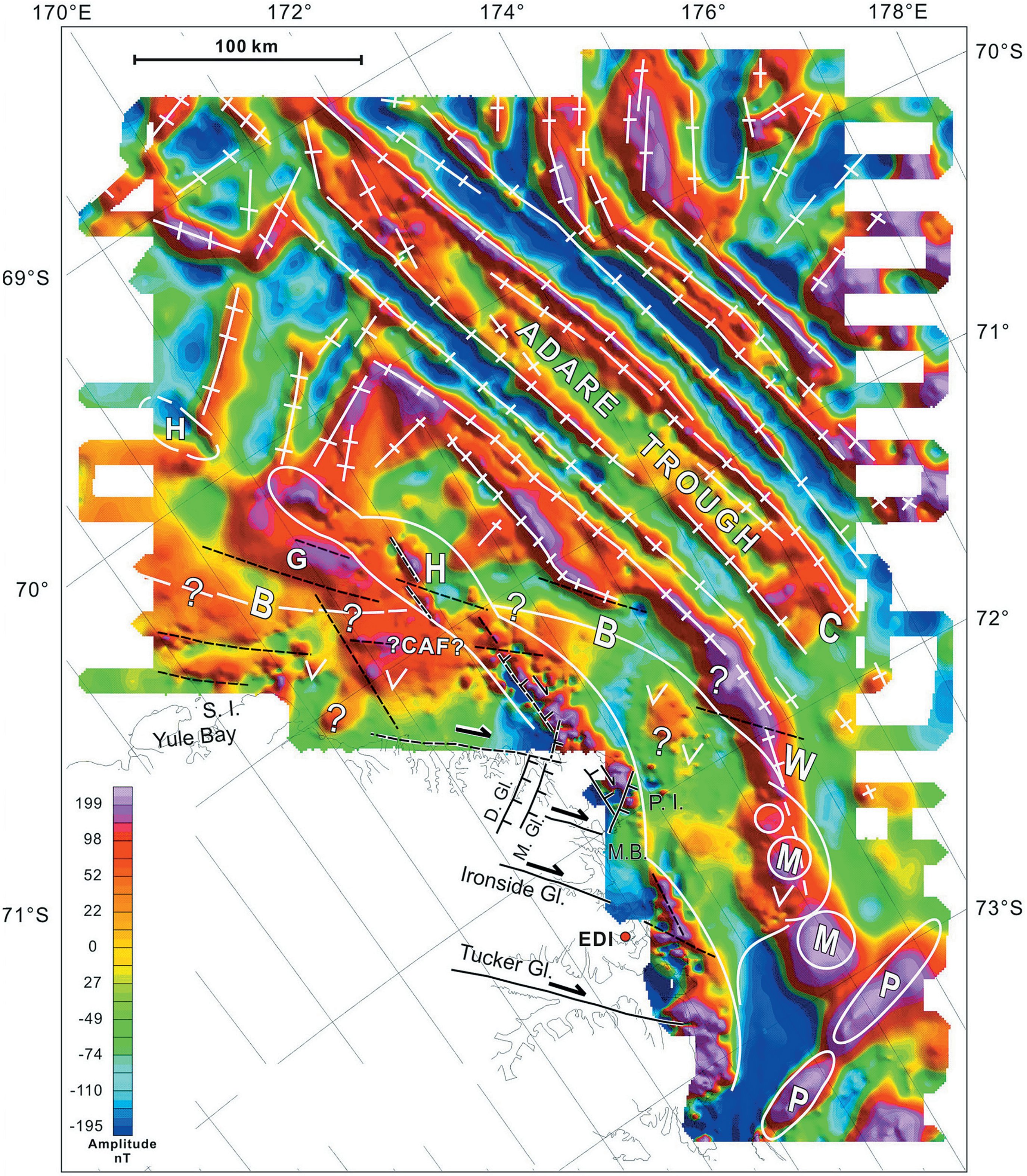

Fig. 8: Anomaly map of the total magnetic field offshore Cape Adare. The sun shade has been cast from 45° (survey grid orientation), at an inclination of 45°. This grid is displayed with an equal area colour scale. D.Gl. = Dugdale Glacier; M.Gl. = Murray Glacier; P.I. = Possession Islands; M.B. = Moubrae Bay; EDI = Edisto base camp. The other labels refer to major magnetic anomalies mentioned in the text.

Abb. 8: Anomalienkarte der Totalintensität des Magnetfeldes im Meeresgebiet vor Cape Adare. Schattierung aus 45° (zur Orientierung des Messnetzes) mit 45° Einstrahlwinkel. Rasterdarstellung in nicht-linearer Farbskalierung. D.Gl. = Dugdale Glacier; M.Gl. = Murray Glacier; P.I. = Possession Islands; M.B. = Moubrae Bay; EDI = Edisto Basis-Lager. Die übrigen Bezeichnungen beziehen sich auf bedeutende magnetische Anomalien, auf die im Text Bezug genommen wird.

fault zone consisting of several parallel lines possibly continuing further to the SE until it reaches the assumed southern continuation of the western flank of the Adare Trough (W in Fig. 8). The northwestern offshore continuation of the Hallett Volcanics forming the Adare Peninsula is apparently dextrally offset in the order of a few kilometres.

The existence of the right-lateral Cape Adare Fault, which was proposed by SALVINI et al. (1997) based on offshore seismic data (see Fig. 1C), remains unclear and cannot be verified by our data with complete certainty, because it generally seems to have no prominent magnetic signature if it exists at all (Fig. 8). As outlined already by DAMASKE et al. (2007) and FERRACCIOLI et al. (2009), we too do not see any significant dextral offsets along the proposed spur of the Cape Adare Fault. There are indeed some apparent en-echelon arrangements of the volcanic rocks indicated by highly positive magnetic anomalies, but these seem to be located roughly 50 km north of the inferred trace of the Cape Adare Fault (see Figs. 1 and 8). However, it might be possible that these displacements are linked to a broader intraplate deformation zone that may be associated with the Balleny Fracture Zone (FERRACCIOLI pers. comm., see also STORTI et al. 2007, FERRACCIOLI et al. 2009).

DISCUSSION

Onshore structural analysis in the greater Edisto and Tucker Inlet area in northern Victoria Land and aeromagnetic data from the offshore region between Cape Adare and the Adare Trough in the Southern Pacific Ocean were used to correlate onshore and offshore tectonic elements and to verify a connection of the Adare Trough with the Northern Basin of the Ross Sea and the existence of the offshore Cape Adare Fault postulated by SALVINI et al. (1997).

Large-scale open and symmetric folds associated with cogenetic bedding-parallel fault-slip data and thrust-/backthrust systems indicate NE–SW to E–W oriented contractional tectonics. Slickenlines associated with bedding-parallel slip are coated with quartz/chlorite fibres and quartz/chlorite veins indicative of fluid flow and up to low-grade metamorphic conditions during deformation. These structures fit the general Ross-orogenic kinematics known from northern Victoria Land (e.g., KLEINSCHMIDT & TESSENSOHN 1987) and are hence considered to be of Early Palaeozoic age. The new finding of a 10-20 m thick succession of greenish greywackes and silt-/mudstones at Edisto Glacier is indicative of basic volcanic rocks in the hinterland of these rocks. Based on sedimentological (WRIGHT 1981, WRIGHT et al. 1984) and geochemical evidence (HENJES-KUNST & SCHÜSSLER 2003), the source area of the Robertson Bay turbidites was located in the area of the evolving Ross-orogenic belt in the W to SW. A scenario suggested by ROLAND et al. (2004) derives the volcanic material of these greywackes from the Bowers Volcanic Arc that collided with the active continental margin of East Gondwana in the Late Middle Cambrian.

Fault-slip analysis has revealed that brittle faults can be devided into two major subsets. The age of these faults must be Neogene, because they are consistently found in all rock types including the <15 Ma old Hallett Volcanics (NADARINI et al. 2003, 2009) and also because a genetic link between dyke intrusion and tectonics is evident locally (ROSSETTI et al. 2000, 2002, LÄUFER et al. 2006a). A conjugate set of predominant NW–SE oriented right-lateral and subordinate NE–SW to ENE–WSW oriented left-lateral faults parallels the main glaciers in the region, suggesting that the course of these glaciers is likely influenced by the underlying tectonic architecture. Locally quite strong transpressional tectonics associated with the right-lateral systems is indicated by flower-structure like arrays (e.g. along the northern margin of Edisto Inlet). A second fault set consists of normal faults striking between NW–SE to NE–SW and is in parts possibly younger than set 1, particularly the Ross Sea coast-parallel NE–SW trending ones. These onshore fault sets between the Pennell Coast and Tucker Glacier are in good alignment with offshore anomalies. A major magnetic lineament is visible far off the Pennell Coast where it obviously cuts through a major positive anomaly (labelled G in Fig. 8) that probably represents a Palaeozoic granitic body. Based on similar magnetic signatures and due to its proximity to the onshore Admiralty block, this body could be related to the Admiralty Intrusives that widely outcrop in this sector of northern Victoria Land and reveal a far wider subsurface distribution (LÄUFER et al. 2006a,b, FERRACCIOLI et al. 2009). Towards the south-east, this lineation can be traced into a series of smaller lines possibly representing potential fault lines coinciding with the very straight and sharp continental edge in this region off the Cape Adare. These offshore aeromagnetic signatures could be related to a much larger and continuous NW–SE trending fault line or fault zone, which is oriented parallel to the major faults recognized along Tucker and Ironside glaciers onshore northern Victoria Land.

FERRACCIOLI et al. (2009) have presented a new aeromagnetic anomaly map and compared onshore aeromagnetic lineaments with Cambrian to Neogene magmatic and tectonic features of the Admiralty Block of northern Victoria Land. They match magnetic lineaments with major fault zones, such as NNW to NNE trending transtensional faults representing splay faults of a Cenozoic intracontinental strike-slip belt (SALVINI et al. 1997, STORTI et al 2007), which seem to control the occurrence of Cenozoic alkaline volcanic rocks. Post-Miocene NE–SW striking extensional faults (FACENNA et al. 2008) coincide with major magnetic lineaments of the same orientation. According to FERRACCIOLI et al. (2009), particularly major Cenozoic alkaline intrusions do not show any significant strike-slip displacement, which may be explained by three possible models. These include (i) emplacement of the magmatic rocks along left-lateral cross faults that accomodated distributed right-lateral shear, (ii) magmatic emplacement related to the opening of the Adare Trough coupled with right-lateral transfer faults, and (iii) a combination of the two by assuming that the opening of the Adare Trough relates to splay faults originating from the Balleny Fracture Zone. On the other hand, our structural data and existing data from the literature (e.g. LÄUFER et al. 2006a, FACCENNA et al. 2008) indicate that the Neogene volcanics were affected by right-lateral tectonics and a subsequent major extensional phase; however, we too could not determine the amounts of displacement along the right-lateral fault planes due to lacking key markers. In particular, our data fit well into the tectonic model presented by FACCENNA et al. (2008) who report a two-fold structural evolution contemporaneous with the emplacement of the Neogene McMurdo volcanic group. These authors distinguish a first dextral transtensional and a second major extensional faulting event associated with the formation of large shield volcanoes driven by large-scale mantle upwelling at the boundary between stable and actively extended lithosphere in the vicinity of the West Antarctic Rift System.

The spreading anomalies of the Adare Trough and an internal structuring can be clearly identified. Spreading in the Adare Trough occurred between 43 and 27 Ma (Cande et al. 2000, Cande & Stock 2006). Because of the eastern termination of the survey area, further work is needed to prove whether there is a continuation of these spreading anomalies into the Northern Basin of the Ross Sea as suggested by Cande & Stock (2006) and Davey et al. (2006).

The Hallett Volcanics forming the Adare Peninsula can be extended into the continental shelf area north of Cape Adare. The anomalies of the Adare Trough are oriented parallel to the possible NNW–SSE striking dextral transtensional to extensional fault that is proposed to have facilitated the extrusion of the volcanic rocks at Adare Peninsula. The combination of both features implies that this fault continues further north into the Antarctic shelf. Moreover, the NE–SW oriented normal faults that separate the Hallett Volcanics forming the Adare, Hallett, and Daniell peninsulas are possibly related to equally oriented anomalies and breaks in the anomaly pattern on the continental (southwestern) flank of the Adare Trough.

CONCLUSIONS

The present structural architecture of northern Victoria Land is generally interpreted in the light of a major intraplate strike-slip belt representing the termination of transform faults in the Pacific Southern Ocean between Australia and Antarctica (e.g. Storti et al. 2007). Our combined aerogeophysical and structural-geological study in the greater Edisto and Tucker Inlet area and in the offshore region north of Cape Adare was therefore mainly performed in order to separate Cenozoic from older faulting events and to evaluate a possible correlation between these major off- and onshore tectonic features and a possible connection between the Adare Trough and the Northern Basin of the Ross Sea. The results are of major importance to better understand the geodynamic evolution of the Ross Sea embayment and its relation to the opening of the Tasman Gateway. The study has led us to the following main conclusions:

- Pre-Cenozoic structures in the Edisto and Tucker Inlet area such as large-scale open folds, bedding-parallel slip, and thrust-/backthrust systems are indicative of NE–SW to E–W oriented contraction related to the Early Palaeozoic Ross Orogeny.
- Neogene (≤15 Ma) brittle faults can be attributed to two major sets: (i) a conjugate strike-slip system with dominant NW–SE directed dextral kinematics and (ii) a possibly in parts younger extensional system with normal faults of NW–SE to NE–SW strike direction, the latter paralleling the present Ross Sea coast line.
- Onshore faults in the survey area between the Pennell Coast and Tucker Glacier are in good alignment with offshore magnetic anomalies. The existence of the Cape Adare Fault proposed by Salvini et al. (1997) could not be verified based on our magnetic data.
- The magnetic signature of the Adare Trough is based on well-defined spreading anomalies correlated with Adare rifting between 43 and 27 Ma. The anomalies are oriented parallel to the Hallett Volcanics of the Adare Peninsula and their northwestward continuation into the Antarctic shelf. A possible connection between Adare Trough and the Ross Sea Northern Basin could not be verified.

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