Exceptionally well-preserved Triassic and Early Jurassic floras from North Victoria Land, Antarctica

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Summary During the IX. German Antarctic North Victoria Land Expedition, fossil plant material from a dozen newly discovered localities has been collected. These floras are of special interest, because compressions yield excellently preserved cuticles and also anatomically preserved material has been found. Cuticle-bearing compression floras, which allow detailed systematic analyses and ecological interpretations, are extremely rare in the Antarctic. The floral succession from *Dicroidium*-dominated floras in the lower part to bennettitalean- and fern-dominated floras in the upper part of the sequence is well in accordance with previous age assessments, which assign a Triassic to Early Jurassic age to the sequence. The ongoing research project may contribute to a better understanding of the palaeoenvironmental characteristics in East Antarctica during the earliest phase of the Gondwana break-up.

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Introduction

The Mesozoic plant fossil record of Antarctica mainly consists of Triassic to Cretaceous sites in the Antarctic Peninsular region and Triassic to Lower Jurassic sites in the Transantarctic Mountains. Apart from Middle Triassic silicified peat deposits from the Central Transantarctic Mountains (see e.g., Taylor and Taylor 1990) fossil floras comprise rather moderately preserved compression/impression material with limited palaeobiological significance.

Cuticular analysis has proven to be a valuable tool in systematic analyses as well as for ecological and climatological interpretations of fossil plants (see e.g., Kerp 1990). However, preservation of cuticles appears extremely rare in pre-Middle Jurassic rocks of Antarctica due to prevalent thermal alteration. Triassic cuticles have so far been only described from the Prince Charles Mountains (Cantrill et al. 1995, McLoughlin et al. 1997). No identifiable cuticles are known from the Jurassic of the Antarctic, although some degraded remains have been reported (Truswell et al. 1999).

In North Victoria Land macrofossils of Mesozoic age have only been described from a single locality at Vulcan Hills, which has yielded a rather poorly preserved compression flora (Tessensohn & Mädler 1987; Fig. 2.1). During the IX. German Antarctic North Victoria Land Expedition (GANOVEX IX) a dozen new fossil localities of Triassic to Early Jurassic age have been discovered in southern North Victoria Land. The collected material comprises plant fossils with excellently preserved cuticles as well as a presumably Lower Jurassic deposit with plants in anatomical preservation.

Geological framework

In southern North Victoria Land the late Early Jurassic Kirkpatrick lava flows cover an approximately 300m-thick continental sedimentary sequence that overlies the crystalline basement. According to recent investigations (Schöner et al., this volume) this succession can be subdivided into three different lithological units (Fig. 1).

The lower unit (Section Peak Formation, SPF) has a thickness of approximately 200-250 m and is mainly composed of trough cross-bedded, medium- to coarse-grained quartzose sandstones. Intercalations of silt- to claystones and coal seams occur towards the top of the unit. The Vulcan Hills flora is dominated by *Dicroidium* (Fig. 2.1) and *Linguifolium*, which suggests an overall Triassic age for the SPF (Tessensohn & Mädler 1987), while various palynological studies indicate that the upper part of the SPF may well extend into the Lower Jurassic (Norris 1965, Pertusati et al. 2006).

The SPF is overlain by a newly described sequence of fine-grained tuffaceous sandstones and siltstones with a thickness of 40 to 50 m ("Shafer Peak Formation, SHF"; Schöner et al., this volume). It is regarded as equivalent to parts of the Hanson Formation in the Central Transantarctic Mountains. An exclusively Early Jurassic age for this formation is deduced from palynological studies of underlying sediments (Musumeci et al. 2006) and radiometric age datings of the overlying late Early Jurassic Kirkpatrick lava flows (e.g., Encarnacion et al. 1996).

Locally, volcaniclastic deposits of mainly hydrovolcanic eruptions, previously described as Exposure Hill Formation, occur. They are found either within diatreme structures cross-cutting through both sedimentary units (SPF and SHF) or as intercalations near the base and/or the top of the SHF. Due to the locally restricted and asynchronous occurrences of these deposits it is proposed to refer to them as Exposure Hill Type (EHT) "events" rather than a

stratigraphic formation (Viereck-Götte et al., this volume; Schöner et al., this volume). Palynological samples recovered from EHT deposits occurring below the SHF at Shafer Peak confirm an Early Jurassic age (Musumeci et al. 2006).

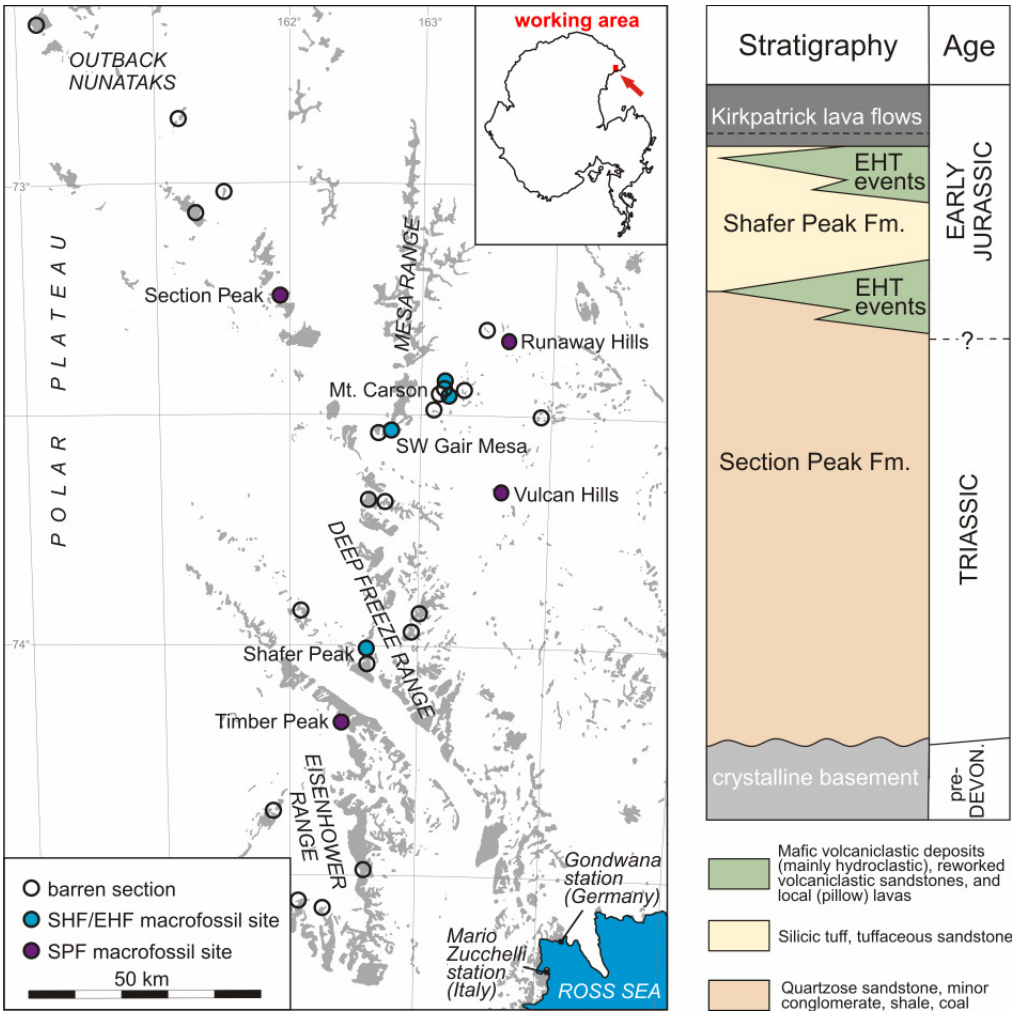

Figure 1. Study area during GANOVEX IX expedition in southern North Victoria Land, with an idealised stratigraphic column showing prevalent lithologies; sills of the Ferrar Group are omitted for clarity.

New macrofossil sites

Fossil sites have been found in each of the above described units but are concentrated in the upper half of the sedimentary sequence. Apart from petrified wood, fossiliferous horizons in the SPF are constricted to intercalations of silt- to claystones and coals within the upper part of the formation. The most important fossil site was found at Timber Peak, a locality so far known for petrified wood and palynofloras only (e.g., Gair et al. 1965), where pelitic beds above a coal seam have yielded a cuticle-bearing compression-flora. This flora is clearly dominated by various species of the seed fern *Dicroidium* (Figs. 2.2 and 2.3), a genus traditionally regarded as typical for the Triassic of Gondwana. In addition, bulk macerations have yielded putative bryophyte cuticles. Leaf fragments of *Heidiphyllum* and *Linguifolium* are found frequently in the beds below the coal seam. Other fossils in the SPF comprise a taeniopterid remain from Runaway Hills, abundant equisetalean axes from the lower part of the succession at Shafer Peak and foliage of osmundaceous ferns from Section Peak.

In the SHF, plant remains occur in isolated horizons throughout the sequence. Though generally highly fragmented, the plant remains show a great diversity and comprise equisetaleans, marattialean and filicalean ferns, putative seed ferns and cycadophytes; conifer remains are very rare. At Shafer Peak a single bed has yielded large fronds of cycadophytes with preserved cuticles as well as frond fragments of dipterid ferns (Fig. 2.6). The assemblage is dominated by the bennettitalean genus *Otozamites* (Fig. 2.7). The SHF floras are the only occurrences of fossil plants with preserved cuticles from the Jurassic of the Antarctic known to date (Figs. 2.7 and 2.8).

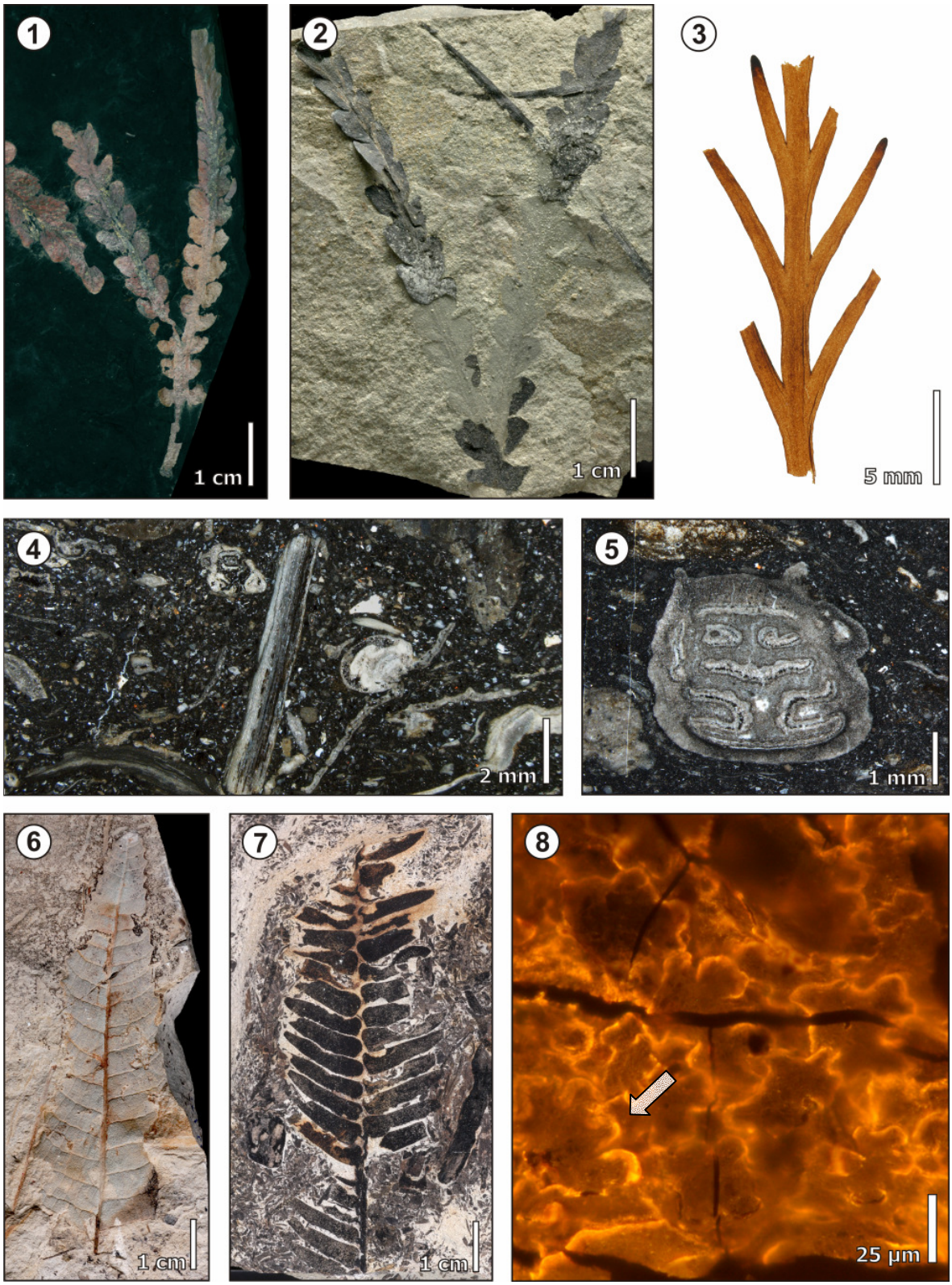

Figure 2: Mesozoic plant fossils from North Victoria Land. **1-3**: Section Peak Formation.- 1: *Dicroidium odontopteroides*; highly altered compression material from Vulcan Hills. 2: *Dicroidium odontopteroides* in cuticular preservation from Timber Peak. 3: *Dicroidium elongatum*; cuticular preparation from Timber Peak material. **4-5**: Exposure Hill facies, Mount Carson.- 4: cross-section through fossiliferous horizon with various plant remains (wood, leaves, axes) in anatomical preservation. 5: cross-section through petiole of a dipterid fern showing characteristic arrangement of vascular bundles. **6-8**: Shafer Peak Formation.- 6: Impression of a dipterid fern frond; Shafer Peak. 7: Cuticle-bearing compression of a bennettitalean frond *Otozamites* sp.; Shafer Peak. 8: Incident UV-fluorescence micrograph of a bennettitalean cuticle from Shafer Peak displaying highly sinuous epidermal cell wall pattern (arrow).

Another important fossil deposit was found associated with pyroclast-bearing, small-scale debris flow deposits at Mount Carson and is therefore related to the EHT facies. It probably represents an EHT event close to the base of the SHF, but the precise stratigraphic position is uncertain since there is no continuous outcrop. At the base of a lacustrine claystone sequence a dm-thick highly fossiliferous debris flow was found. It comprises structurally preserved plant axes, foliar remains and fructifications of mainly dipterid ferns and cycadophytes in various degrees of decomposition. More degraded remains are frequently encrusted by microbial mats, in some of which also fungal remains were found.

Discussion

Dicroidium-dominated floras occur in the upper part of the SPF. Plant associations of the SHF and EHT facies are in contrast dominated by cycadophytes and ferns; *Dicroidium* appears to be totally absent. The floras seem to confirm age assessments by previous authors which suggest a Triassic to Early Jurassic age for the SPF (Norris 1965, Tessensohn & Mädler 1987, Pertusati et al. 2006) and an exclusively Early Jurassic age for deposits overlying the SPF (Musumeci et al. 2006). According to previous data and our preliminary results, the Triassic/Jurassic boundary is supposed to lie close above the plant-bearing beds in the uppermost part of the SPF. Interestingly, hardly any conifer foliage was found. The clear dominance of hygro- to mesophilous floral elements may support evidence for a wet depositional setting. Furthermore, the preservation of cuticles in pre-Middle Jurassic rocks of North Victoria Land shows that thermal alteration due to Ferrar magmatic activity is not inevitably as extensive as previously thought (e.g., Playford 1990).

The newly recovered fossil material is subject of an ongoing research project. The excellent preservation of some of the floras is unique for the Antarctic. Cuticular analyses and anatomical studies of the floras can contribute to our understanding of the palaeobiology of Mesozoic Antarctic plants and the environmental conditions they lived in.

Summary

This extended abstract gives an overview about newly discovered fossil floras from the Triassic and Lower Jurassic of North Victoria Land, Antarctica. The most important finds comprise a cuticle-bearing *Dicroidium*-flora and cuticle-bearing bennettitalean-dominated floras as well a deposit with structurally preserved dipterid ferns and cycadophytes. Highly remarkable is the excellent state of preservation of these floras which is rarely found elsewhere in the Lower Mesozoic of Gondwana.

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