Submersible-based observations of in-situ fossil tree trunks in Late Cretaceous seafloor outcrops, Orange Basin, western offshore, South Africa

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ABSTRACT

A submersible dive undertaken over seabed outcrop situated on the middle shelf off the Namaqualand coast, at a depth of 136 to 140 mbsl, about 32km offshore, revealed an abundance of *in-situ* fossil tree trunks in exposed Late Cretaceous (Late Coniacian) seafloor outcrop. Based on regional Side Scan Sonar interpretations, it would appear that this outcrop is unique to the dive location, covering an approximate 2km^2 area of seabed. Integration of these observations with a regional seismic stratigraphic and biostratigraphic framework has enabled more accurate constraints to be placed on the ages of the wood than was previously possible. Two species of fossil wood belonging to the Podocarpaceae were identified from samples collected by the submersible: *Podocarpoxylon jago* Bamford and Stevenson and *P. umzambense* Schultze-Motel. Palaeoenvironmental analysis shows that the proximal Coniacian succession for the Orange Basin was typified by a well-vegetated coastal plain, which was periodically waterlogged. The coastal plain experienced repeated periods of progressive drowning of the incised valley systems cutting through the coastal plain and the subsequent development of wave-dominated estuarine incised valley fill systems. The fossil wood recovered from the dive-site is typified by a lack of distinct growth ring development. This implies either a lack of seasonality or sufficient available water all year round, with no low temperatures to stop plant growth. This observation, together with complementary sedimentological and micropalaeontological analysis suggests a temperate palaeo-climate for the area.

Introduction

Although fossil wood occurrences are abundant in southern African terrestrial sedimentary sequences, they have received limited study. Reworked Early Cretaceous fossil wood clasts have been recovered from raised beaches on the Namaqualand coastal plain, west coast of South Africa (Bamford and Corbett, 1995) and the adjacent offshore continental shelf (Bamford and Corbett, 1994). The offshore samples described by Bamford and Corbett (1994) were recovered from airlifted seabed slurry samples from De Beers Marine (Pty) Ltd diamond sampling vessel operations.

This paper provides detailed geological descriptions of a submersible dive carried out over the continental shelf during November 1997, which revealed an abundance of *in-situ* fossil (silicified) tree trunks in exposed Late Cretaceous seafloor outcrops. Integration of these observations with a regional seismic stratigraphic and biostratigraphic framework enable more accurate constraints to be placed on the ages of the wood than was previously possible, and has also aided in providing further palaeoenvironmental indicators for the Late Cretaceous succession in this area. The work presented in this paper complements two other publications, a detailed taxonomy of the fossil wood (Bamford and Stevenson, 2002), and a study of incised valley fill seismic stratigraphy and biostratigraphy of the Late Cretaceous succession of the Orange Basin (Stevenson and McMillan, 2004).

Locality and Geological setting

This study is situated on the middle shelf of Namaqualand, west coast of South Africa, between 27°41′ south 14°38′ east and 27°39′ south 35°12′ east, some 32km offshore, between Port Nolloth and Kleinzee (Figure 1). Water depths for this area range between 121 to 148mbsl (metres below sea level). The slope of the middle shelf is approximately 0.06° and exhibits an overall gentle topography, with a maximum vertical relief variation in the order of 5m.

The west coast continental margin is essentially a divergent plate margin consisting of syn-rift graben basins and a post-rift, or passive basin, termed the Orange Basin. Rifting between the African and South American plates occurred during the Late Jurassic to Early Cretaceous (140 to 114 Ma). The post-rift Orange Basin has its depocentre off the Namaqualand coast and has a sedimentary fill which is at least 8000 m thick (Gerrard and Smith, 1982). The outcropping seafloor geology across the middle shelf is dominated by

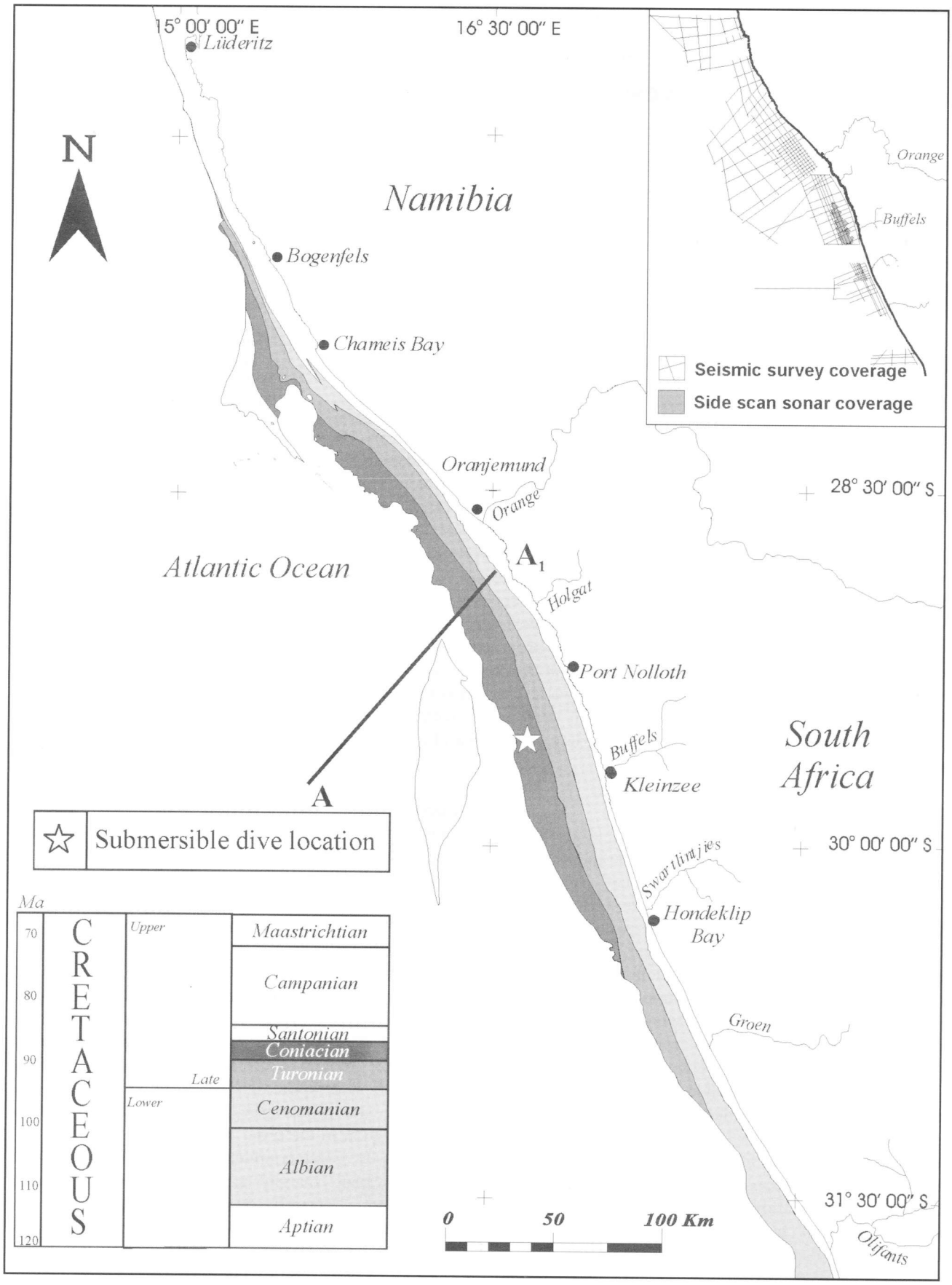

Figure 1. Map showing distribution of Late Cretaceous outcrop off Namaqualand based on interpretation of seismic-profile data. The location of the submersible dive is also shown. Insert shows distribution of seismic data and Side Scan Sonar data used in construction of the regional geological model.

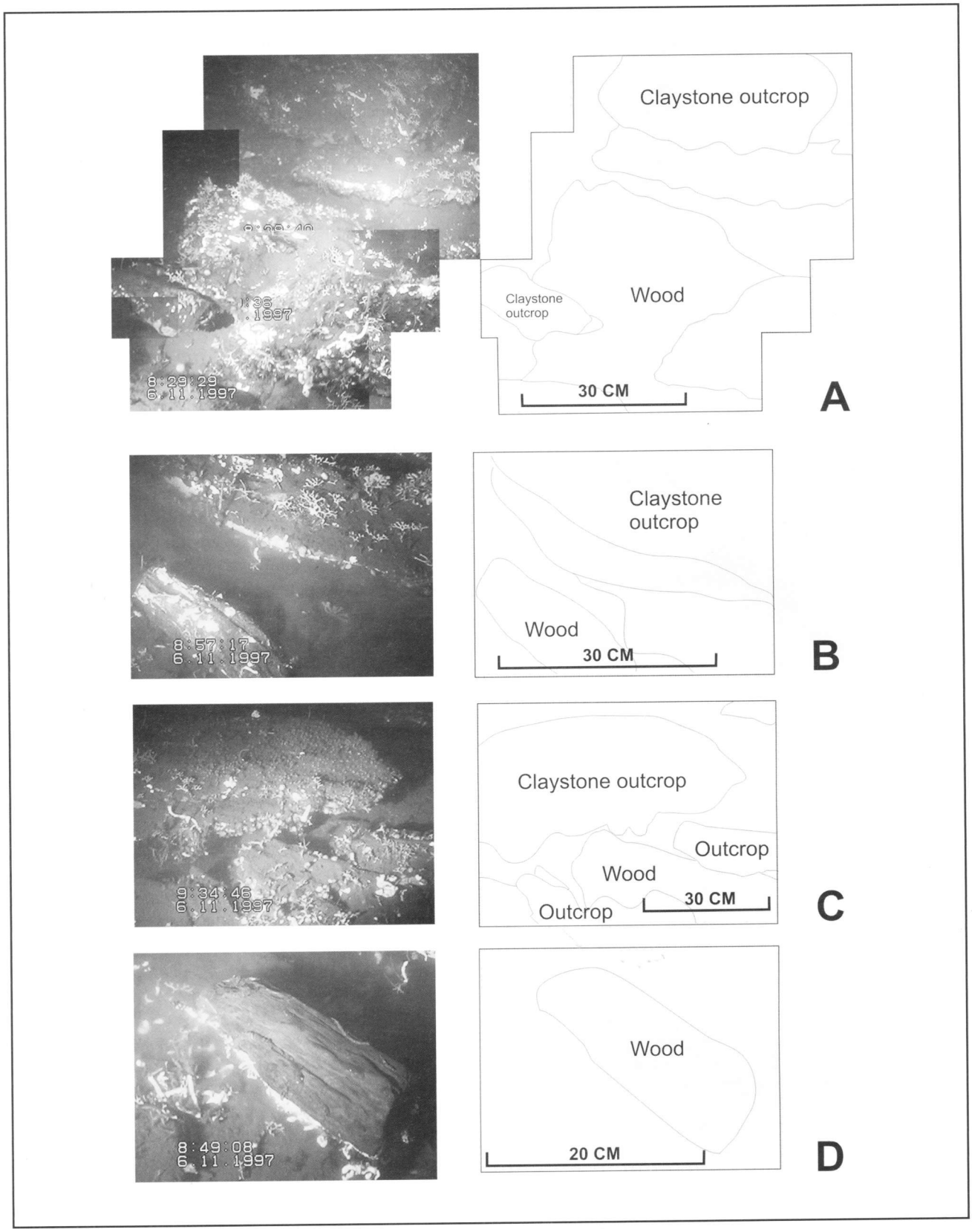

Figure 7. Video frame-grabs from the *JAGO* dive footage. (**a**) Outcrop (?claystone) associated with Side Scan Sonar Facies 4a (see Figure 4). These exposures extend unbroken for lengths of greater than 5m along strike and are usually little over 0.5m high and 1m wide, with a bed thickness of not more than 25cm. A fossil tree trunk is also visible in this image. (**b**) Fossil wood specimen found underneath an outcrop overhang. (**c**) Outcrop associated with Side Scan Sonar Facies 4a, showing an extensive tabular sheet of possible claystone in the background, and a large specimen of fossil wood, too big for recovery, within a claystone outcrop in the foreground. (**d**) Fossil wood specimen, showing distinct prolate shape, angular and blocky cross-section, with very distinct high-relief surface ridges along the length of the trunks and logs, commonly associated with these specimens.