THE INTERNAL FOLD AND THRUST BELT PLAY PAPUA NEW GUINEA

INTRODUCTION

The New Guinea Orogen is a complex megatectonic feature, which originated in the zone of interaction between the Australian Plate to the south and the Pacific Plate to the north. In Papua New Guinea (PNG), it is 600 kilometres in length by up to 230 kilometres in width. It continues westwards into Irian Jaya with similar dimensions. In PNG, it is divided by fairly abrupt dogleg bends into three segments, two trending NNW, the middle one trending NW. Within the Orogen, and on the foreland to the southeast of it, Late Paleozoic Basement is overlain by rift and passive margin sequences of Triassic through Paleogene. The Neogene to Recent stratigraphic section comprises backarc and foreland basin sequences related to the collision between the Pacific and Australian Plates. Folding, thrusting and uplift took place from the Late Miocene onwards. The region continues to be seismically active at the present day. More detailed accounts of the geology of the Orogen and of PNG in general are given in Dow (1977), Home et al (1990), Smith (1990), Francis (1990), Struckmeyer et al (1993) and Davies et al (1996).

The following structural zones (described from SE to NW) are recognised within the Orogen in PNG:

The Papua Fold and Thrust Belt (PFTB) consists of an **external zone** to the SE and an **internal zone** to the NW.

The **external zone** is characterised structurally by numerous thin skinned thrust anticlines. Neogene to Recent section outcrops widely at surface, but a Triassic through Cretaceous section is known from inliers and drilling. Most of the section is shallow water sediment and is unmetamorphosed. There are hardly any volcanics. It is the external zone of the PFTB that has seen most of PNG's petroleum exploration to date, and in which all production to date has taken place.

The **internal zone** (IFTB) differs in that it is characterised structurally by basement involved faults that bring horst blocks of older section, even basement, to surface. The stratigraphic column is the same age as that in the external zone, but is mainly in a deepwater facies. There are more volcanics than in the external zone.

The external and internal zones are considered to be wholly autochthonous parts of the Australian Craton. They comprise Terrane A as shown on the poster.

The **mobile belt** is a zone of thrust and fault bounded slices of Mesozoic and Tertiary sediments and volcanics, partly in a metamorphic facies, and

ophiolites, interpreted as obducted oceanic crust. The Mesozoic sediments, and their metamorphosed counterparts, are mainly in a deepwater facies, and have a considerably higher portion of volcanics than in the PFTB.

The mobile belt is here interpreted to be a series of continental slivers that were split off the northern edge of Gondwanaland during the middle and late Mesozoic. In the late Cretaceous, they were restacked, and re-accreted to the margin of Gondwanaland in the Tertiary. The ophiolites represent the oceanic floor that originally separated the fragments, while some of the metamorphics especially the glaucophane schist were formed in trench environments. Terranes B and C are thought here to be two distinct accreted terranes, the accretion of Terrane B predating that of Terrane C.

The Aure Fold Belt is a N-S trending fold belt, which mainly exposes *geosynclinal* late Tertiary sediments at surface. It was apparently formed by compression between "Scrapland", a zone of exotic basement and oceanic terranes lying to the east, and the mainland of PNG (Rogerson and Hilyard, 1990).

Compared to the external zone of the PFTB, (e.g. Rickwood, 1990; Warren Carey, 1990), the IFTB, Mobile Zone and Aure Fold Belt are almost unexplored. They offer potential source rocks, reservoirs and seals, have a wealth of structure, and have oil and gas seeps, testifying to the existence there of active petroleum systems. Jointly, they are referred to on the poster as the Area of Interest. However, it is recognised that the greatest potential lies in the IFTB. That potential is now reviewed in the following sections.

SOURCE ROCKS

Triassic. The black shales of the Yuat Formation, present in Triassic outcrops in the Mobile Belt, are possible source rock.

Jurassic. The Maril Shale and Om Beds are mainly black carbonaceous shales (Davies, 1982, 1983) and are rated as potential sources.

Cretaceous. The Chim Formation comprises calcareous grey to black shale and mudstones. Although none are described as carbonaceous, there may be source rock potential.

Tertiary. The Moogli Mudstone is described as a soft grey foraminiferal mudstone, and may possibly have source rock potential, as might shales and mudstones in the Aure Beds. Apart from such general considerations, oils from two seeps at the SE end of the Yaveufa Syncline have biomakers that type them to a Cainozoic source rock (Murray et al, 1993). This demonstrates without question the existence of at least one Tertiary petroleum system.

Based on thermal modeling of three pseudowells, the **Triassic** is likely to be at least into the wet gas window, and probably into or through the dry gas window. The **Jurassic** Maril Shale in Tambul-1 is mostly still in the oil window, but in the much deeper Yaveufa-1, it is now at the base of the dry gas window.

The oil seep near Mingende in the Wahgi Valley might represent an earlier charge of oil that is now being displaced by such a later gas charge. The **Cretaceous** Chim Formation varies from being scarcely mature in Tambul-1 to being in the wet gas window in Yaveufa Syncline-1. Not surprisingly, the **Tertiary** only reaches a reasonable level of maturity in the Yaveufa-1 pseudowell, which is only around 10 kilometres from the Tertiary sourced Lufa seeps.

RESERVOIRS

Triassic. The Kuta Formation comprises up to 250 metres of massive and reefal limestone (Bain et al, 1975). Reef limestones could be present at depth along the NW and SE plunge of the Kubor Anticline, and possibly down the E plunge of the Om Uplift, assuming this to have been positive during the Triassic. A few metres of arkose at the base of the Kuta Formation are not considered to offer any significant potential.

Jurassic. The Maril Shale and the Om Beds mainly comprise black carbonaceous shales laid down in deep water euxinic environments. Rogerson et al (1987, p. 8) draw attention to coarse feldspathic sandstone in the Om Beds. Bain et al (op cit) refer to fine to medium grained sandstone interbeds up to2 metres thick, and report one bed as being 200 metres thick (op cit, p. 29). Given the environment of deposition of the shales, these sandstone bodies are likely to have been deposited as turbidites.

Cretaceous. The Kondaku Tuffs include lithic sandstones and tuffaceous sandstones that could provide potential reservoirs (Bain and MacKenzie, 1974). The laterally equivalent Lower Cretaceous (ibid) comprises massive to thick bedded dense lithic sandstones. The overlying Chim Formation mainly consists of calcareous grey shales, but there are laminated and well sorted sandstones (ibid), though thicknesses are not reported. Bain et al (1975, p. 39) refer to thick sandstones being present. A single sandstone bed 31.5 metres is reported from a measured section (ibid, p. 41). The Late Cretaceous Pale Sandstone in the SE corner of the IFTB comprises 200 + metres of fine grained quartz arenites.

Tertiary. Reservoirs could be present in the Urubea Sandstone and the Pima Sandstone, both of Paleocene age. The former is deposited as medium grained, calcareous and glauconitic, with the grains consisting of quartz, feldspar and volcanolithics. The latter are thick-bedded fine to coarse grained feldspatholithic sandstone. They may suffer from a limited distribution. By far the greatest Tertiary reservoir potential must exist in the widespread Eocene through Miocene limestones of the Nipa and Mendi Groups. These are known to be cavernous where they outcrop at surface, and could provide significant reservoirs where they are covered by an adequate seal such as the Lai Siltstone, Ka Mudstone or Aure Beds.

SEALS

Jurassic. The Maril Shale would form an excellent seal to interbedded sandstones, and to limestones of the Triassic Kuta Formation.

Cretaceous. The Chim Formation shales can be expected to provide good seal to reservoirs in the Kondaku Tuffs.

Tertiary. The limestone reservoirs could be sealed by interbedded tight limestones or by the generally impermeable clastics of the Aure Beds and equivalent formations.

STRUCTURES

Examination of the Geological Survey of Papua New Guinea 1:250,000 sheets covering the Area of Interest reveals numerous surface anticlines that could mature into attractive four way dip closed prospects at Jurassic, Cretaceous and Tertiary levels. These are not shown on the Geological Map panel, but are depicted somewhat schematically.

The Triassic reefal limestones of the Kuta Formation described at surface on the Kubor Anticline could also be present down its SE and NW plunge, where they could be sealed by the Jurassic Maril Shale.

Depositional pinchout of the sandstones interbedded in the Jurassic Maril Shale could provide stratigraphic trap potential. In additional, there could be unconformity pinchouts against the Kubor Anticline, and drape anticlines over it.

ACREAGE AVAILABILITY

The five known sedimentary basins in PNG include the Papuan, North New Guinea, Cape Vogel, Bougainville and New Ireland. The Papuan Basin is the basin that has undergone the highest level of petroleum exploration in the country, and is also the only basin in which commercial quantities of crude oil and gas have been discovered and are being produced. The other basins have been the subject of relatively little interest, and in some cases no exploration.

The play type identified in this Area of Interest is located along the northern fringe of the Papuan Basin. It is almost unexplored to date, however, the presence of all the necessary factors required for petroleum accumulation confirms the area's prospectivity.

CURRENT FISCAL TERMS

Refer to Petroleum Fiscal Terms folder.

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