Day: Wednesday 26 April **Session: 2**
Time: 12:00pm

Influence of Structural Inheritance on the Moattama – East Andaman Basins and the Present Day Plate Boundary

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The Moattama Basin lies in offshore Myanmar bounded to the west by the Yadana-M8 High and to the east by the Tanintharyi - Mergui Shelf. The depocentre continues south as the East Andaman Basin which is bounded to the west by the Alcock-Sewell rises. Together, the two basins are also referred to as the Martaban Basin (e.g. Racey and Ridd, 2015). The main depocentre is dominated by a very thick Late Miocene to Recent delta system, and includes a less well known Late Oligocene-Early Miocene syn-rift. The Tertiary sediments are thickest (>8km; Racy and Ridd, 2015) in the Moattama region and adjacent to the shelf, and thin to ~5 km in the southern deep water blocks (Fig. 1) where water depth is >~2,500m.

Frogtech Geoscience has completed an integrated study to understand the geodynamic evolution of basement and basin systems of onshore and offshore Myanmar. A key part of this project has been interpretation of the nature of basement, including basement terranes, major boundaries, composition and fabric. This study has highlighted the influence of basement and structural inheritance on the Moattama – East Andaman basins.

The Tanintharyi – Mergui Shelf to the east of the elongate depocentre is ~50km in width in the north and widens to ~200km in the south (Fig. 1). Published seismic lines and cross sections show a gently west-dipping basement surface which then deepens rapidly due to a steeper dip and one or more faults that step down to the west (e.g. Racy and Ridd, 2015). Outcrop of basement rocks in the onshore to the east comprise metasediments intruded by numerous granitoids which form the Mergui magmatic arc (Cretaceous to Eocene; Mitchell et al., 2012). Various filters of the gravity data have been used to assess the nature of the basement beneath the shelf. The data shows a strong linear trend of positive and negative gravity anomalies (Figs 1 and 2) interpreted as elongate granitoids intruding basement of somewhat higher density, consistent with outcropping geology. The widespread intrusions of the Mergui Arc have produced a relatively competent basement terrane which forms a broad basement high. Small elongate rift basins within this competent terrane (c.f. Racy and Ridd, 2015) are controlled by the pre-existing ~ N-S to NNE-SSW basement fabric. The stretching factor is relatively low (1.2 to 1.5).

The western basement high to the Moattama – East Andaman basins includes the Yadana-M8 highs in the north, and the Alcock and Sewell rises (Fig. 1). The rises are separated by the Central Andaman Basin which is interpreted as ocean crust of Pliocene (Curray, 2005) or mid to late Miocene age (Morley and Alvey, 2015), although Rangin and Choi (2015) question the interpretation of oceanic crust based on industry seismic (see also Morley and Alvey, 2015). Volcanic basement has been intersected in numerous wells on the Yandana-M8 highs (e.g. Racy and Ridd, 2015) and dredge samples from the Alcock-Sewell rises include volcanic units (with one K-Ar age date of ~20 Ma; Curray, 2005). The nature and origin of the basement is not clear cut, but we favour continental crust based on the gravity response and structural fabric (cf. Morley and Alvey, 2015), that has been extensively intruded during arc magmatism. The West Burma Terrane along strike to the north provides a possible analogue.

There are no direct observations to indicate the nature and the evolution of the basement beneath the Moattama-East Andaman basins, although there are a few constraints to guide interpretation. The basement is rheologically weaker than the adjacent basement highs and has localised extensional deformation. The basement is deeper and the crust is significantly thinner than the adjacent highs as indicated by the calculated stretching factor of ~2 to >10, and significant sediment thickness (>8km in the north and >5km in southern deep water area). Gravity data shows a broad linear pattern beneath the basins, with a negative anomaly (pink stars) adjacent to the Tanintharyi - Mergui Shelf, and an elongate positive anomaly (white stars) adjacent to the Alcock-Sewell rises (Figs 1 and 2). The presence of a strong positive gravity anomaly beneath the thick Tertiary basin requires high density material beneath the basin, i.e. either oceanic crust or shallow mantle beneath highly thinned to transitional continental crust. The gravity response (i.e. texture and amplitude in a range of different filters), in conjunction with the geodynamic setting, is most consistent with interpretation of the positive gravity anomaly as highly thinned to transitional crust, including serpentinised mantle that may have been exhumed in some areas. Morley and Alvey (2015) similarly interpret continental crust but include a segment of oceanic crust at the northern end of the positive anomaly. The positive gravity anomaly of the highly thinned to transitional crust shows a gradual decrease in amplitude eastward into the linear negative gravity anomaly adjacent to the shelf (Figs 1 and 2). The gradual change precludes a sharp faulted boundary and is more consistent with increasing thickness of continental crust to the east. The dominant lithology of this highly thinned basement is interpreted as metasediment based on the gravity response and geodynamic setting.

Additional insights into the nature of highly thinned basement beneath the Moattama – East Andaman basins come from the outcropping geology of northern Myanmar. Age dating and isotopic constraints from the eastern ophiolite belt indicate formation of oceanic crust by ~173 Ma (Myitkyina; Liu et al., 2016) and initiation of intraoceanic subduction and island arc development by ~160 Ma (Jade area; Shi et al., 2008; Qiu et al., 2008). The remnants of this ocean basin outcrop adjacent to the northern Sagaing Fault marking the approximate boundary zone between the West Burma Terrane and the Sibumasu Terrane (e.g. Metcalfe, 2013; Mitchell et al., 2012). The Sagaing Fault continues south beneath the Moattama – East Andaman basins. The present day Sagaing Fault may represent a relatively young structure (e.g. Rangin et al., 2013) but it has formed within an older orogenic belt.

Although the basement beneath the Moattama-East Andaman basins cannot be directly observed, integrated interpretation of potential field data constrained by onshore geology, as well as published maps and seismic sections, provides significant insights to the nature and evolution of the underlying basement. The basement likely consists of a metasediment dominated zone that originated as a narrow orogenic belt during collision between the Mergui Arc (which forms the western margin of the Sibumasu Terrane) and Alcock-Sewell rises. Strain during Oligocene to Miocene oblique extension / transtension preferentially localised in the weak sediment-dominated belt resulting in highly thinned crust, serpentinisation and local mantle exhumation. Similar patterns of strain localisation in narrow, weak collisional belts between competent blocks (or cratons) have been documented around the world. Strain partitioning is strongest on those boundaries with the greatest rheological contrast. Thus hyperextension and mantle exhumation are more likely to develop at the boundary of a craton or in narrow mobile belts between competent blocks where rheological contrast is the highest (Pryer et al., 2015).

This new understanding of basement has fundamental implications for the location and nature of the present day plate boundary within the highly thinned crust beneath the Moattama – East Andaman basins. The highly thinned basement in this zone is interpreted to comprise highly rotated fault blocks bounded by low-angle faults merging into a major detachment surface within serpentinised mantle (or possibly within the lower crust). Given this crustal architecture, strain across the present-day plate boundary should be accommodated mainly within this ductile detachment surface, and associated low-angle basement faults, rather than stepping across the Moattama Basin along a set of steep structures.

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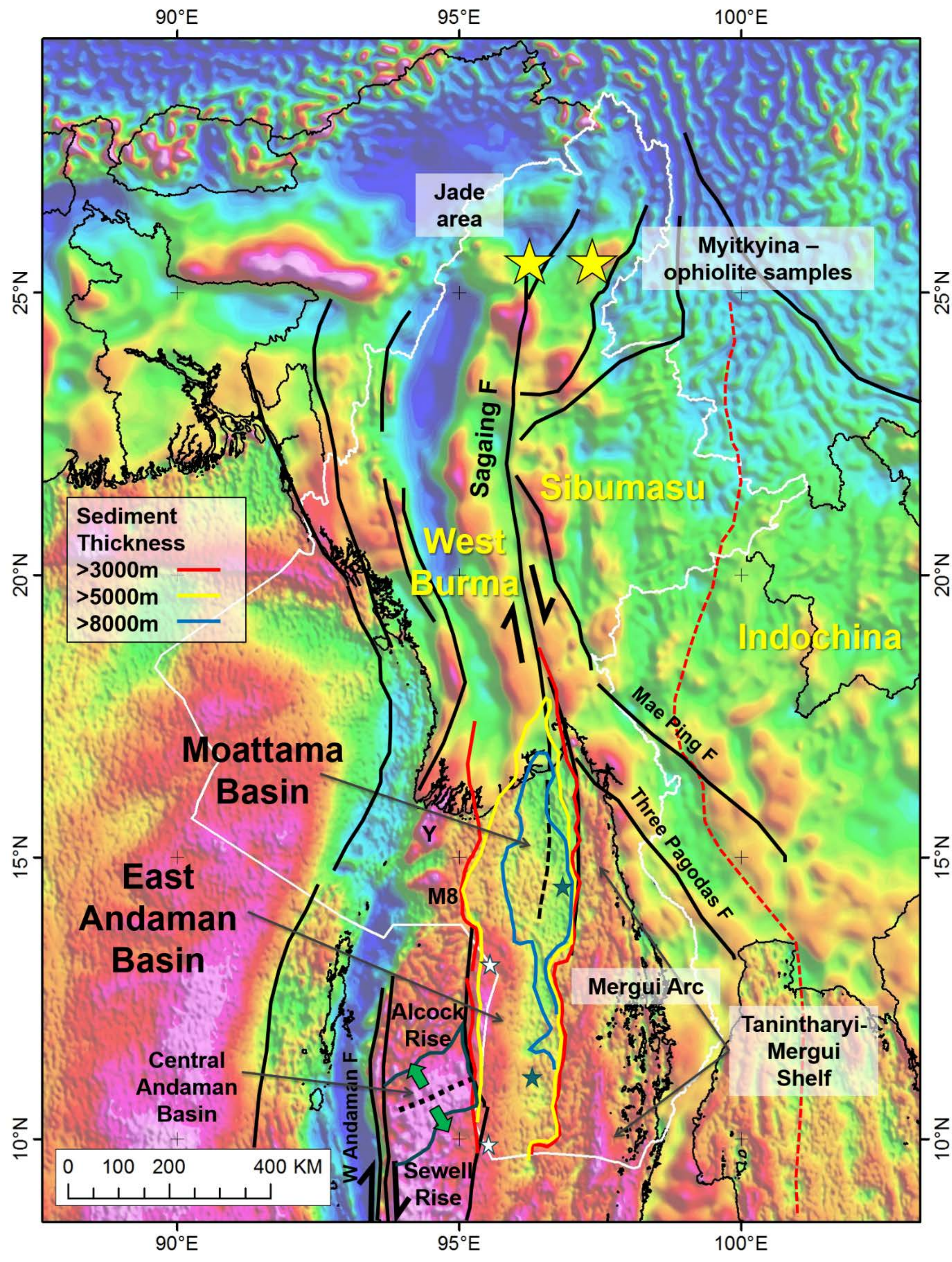

Figure 1: Image showing Isostatic Residual of Bouguer Gravity overlain with sediment thickness contours for the offshore Moattama-East Andaman basins. Thin black lines = country boundaries; white outline = Myanmar EEZ; thick black lines = some of the major faults; red dashed line = boundary of Sibumasu and Indochina; white and pink stars highlight the positive and negative gravity anomalies beneath the basins; the yellow stars indicate the locations of age dating sites discussed in text. Y= Yadana High, M8 = M8 High.

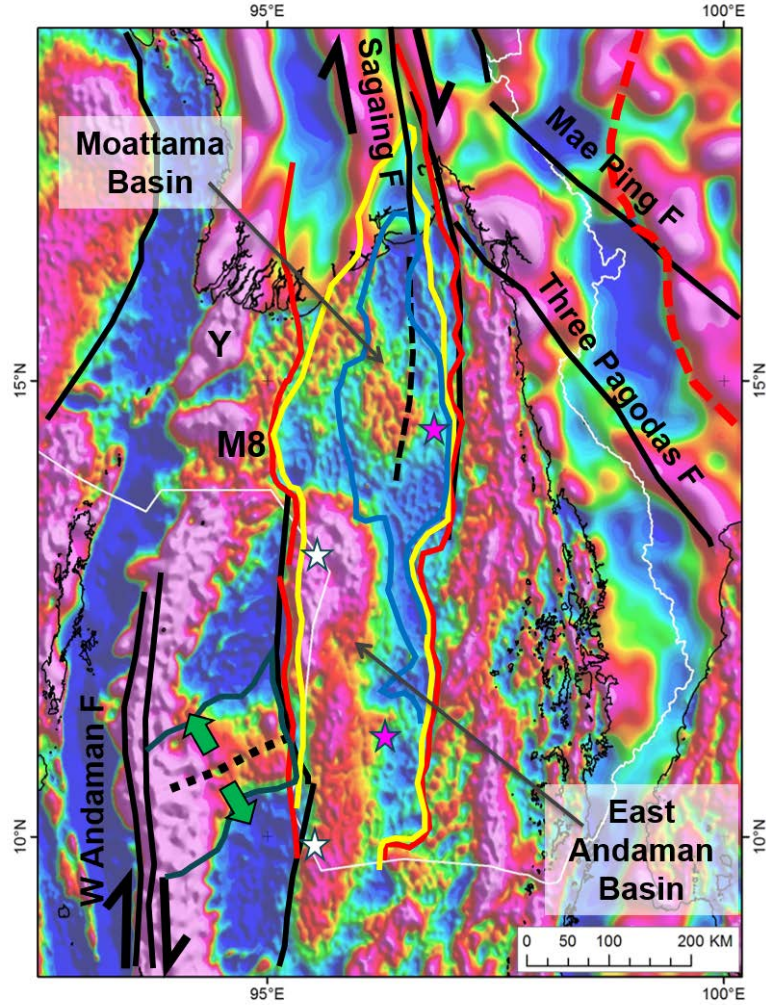

Figure 2: Image showing 300km High-pass of Bouguer Gravity overlain with sediment thickness contours for the offshore Moattama-East Andaman basins. This filter emphasizes the gravity anomalies with a wavelength of 300km or less, and is useful for highlighting variations within the basement. Refer to Figure 1 for legend.

Speaker biography

*Karen Connors is a Principal Geoscientist with Frogtech Geoscience, where she oversees the development of SEEBASE® products and leads client projects. Karen holds a BSc (1986) from Dalhousie University, Canada, and a PhD from Monash University, Australia (1992). She completed a Postdoctoral Fellowship at the Geological Survey of Canada. Karen has ~30 years' experience as a geologist including time as a researcher, as an employee in both the minerals and petroleum industries and as a consultant. Over the last 10+ years, she has focused on integrated interpretation of potential field data sets with seismic and other data to assess the basement control on basin evolution and implications for the petroleum prospectivity in regions around the globe. Karen is a member of Petroleum Exploration Society of Australia, and a Fellow of the Geological Society of London and the Australian Institute of Management.