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ORAL PRESENTATION

Volcanic Reservoirs of SE Asia

Andy Racey[1]

[1]*Andy Racey Geoscience, UK*

andy@andyracey.com

Around 60% of the world's conventional hydrocarbon resources are in sandstones, 40% in carbonates and less than1% in volcanics and other types of "basement". However, extrusive volcanic rocks are present in most geological settings, occur over the entire geological column, often cover large areas and can form a large proportion of a basin's fill.

To date there are over 300 global records of hydrocarbon discoveries and significant shows in volcanic rocks of which around 170 have proven reserves. Most producing volcanic reservoirs occur onshore and at a broad range of depths from a few hundred to 5000 m. Fields are often located close to a mature source and are more common in rifts and back-arc basins, where volcanic rocks and mature source rocks are commonly juxtaposed. Since volcanic rocks are less affected by compactional porosity loss during burial, due to their greater mechanical strength, they can retain their porosity in the deeper parts of basins where more conventional reservoirs are unproductive.

Within SE Asia, producing volcanic reservoirs include: Upper Carboniferous, Lower Cretaceous and Palaeogene in the Songliao, Junggar, Erlian, Sichuan, Santanghu and Bohai Bay basins of China; Miocene-Pliocene in the Nigata and Akita basins of Japan; Miocene in the Petchabun Basin of Thailand and Moattama Basin of Myanmar; and the Eocene-Oligocene of onshore NW Java, Indonesia. Amongst these, the recent Aung Sinkha discovery in Myanmar represents the only offshore discovery.

Japan has a long history of producing hydrocarbons from volcanic rocks with the first significant discoveries being in 1958. Japan is a major importer of oil and gas with only 0.3% of total oil and 3.3% of total gas requirement being provided by indigenous resources, of which around 75% are from volcanic rocks. Production is from onshore and is mainly from Lower-Middle Miocene rhyolites (the "Green Tuff") of the Niigata and Akita Basins. These submarine volcanics were erupted in a back-arc basin setting during the opening of the Sea of Japan. The total basin fill is greater than 7 km thick and includes deep-marine source rocks and thick mudstone sealing units. The largest field discovered to date is Minami-Nagaoka with an estimated recoverable resource of 1 Tcf and 33 MMbbls of condensate from reservoirs at between 3800 m and 5000 m depth.

By contrast, exploration in volcanic rocks in China's onshore basins has been a more recent development. In China such rocks cover around 2.1 million km^2 with "potential" volcanic reservoirs occupying around 20% of this area. Since 2005, volcanic reservoirs have become primary exploration targets with major gas discoveries in the Songliao Basin. To date 13 onshore basins have produced hydrocarbons from volcanic rocks of which nine have produced oil, two gas and two oil and gas, with a further three basins having hydrocarbon shows. This has resulted in the discovery of over 40 fields. Several of these rift basins (Junggar, Tarim, Songliao and Bohai) are classified as deep in having a total fill of between 4500 m and 7000 m. The total resource potential for China's volcanic rocks is estimated at between1.9 and 2.6 Bbbls of liquids and around 148 Tcf of gas onshore, with a proven resource in 2014 of 365 MMbbls of oil and 14 Tcf of gas. Hydrocarbons are recovered from a broad range of depths (1000 m to 5000 m) with the deepest well to date being to 7000 m.

Discoveries in Thailand and Myanmar are within fractured Miocene volcanics and include the Na Sanun and Bo Rang fields onshore Thailand and the Aung Sinkha Field offshore Myanmar. In the case of the Thailand examples there is also additional production from associated Miocene sandstones.

Many volcanic sequences in sedimentary basins are either unexplored or underexplored and the presence of volcanic rocks in a region should not always condemn an area from hydrocarbon exploration. However, exploring in such areas does require a different exploration mindset and methods.