Neogene Volcanic Reservoirs From the Niigata and Akita Basins of Japan

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ABSTRACT

Miocene rhyolitic/dacitic and Pliocene basaltic/andesitic volcanics from Japan form economically important hydrocarbon reservoirs in several fields within the onshore Niigata and Akita Basins. These volcanics were erupted suaequeously onto the sea bed during the opening of the Japan Sea back-arc basin which was initiated in the Early Miocene and are interbedded with deep marine sediments to produce a Neogene basin fill in excess of 7km thickness. This basin fill includes Middle-Late Miocene source rocks and Miocene to Pliocene mudstone sealing units and intraformmational tight volcanic horizons. Historic production from these fields extends back to 1958 and was mostly from reservoirs at relatively shallow depths (<2000m) which were often drilled on surface anticlines. More recent large gas-condensate discoveries made in the 1980s were from markedly greater depths (>4000m). Hydrocarbons are currently produced from reservoirs as deep as 4500-5000m (in the Minami-Nagoaka and Yoshi-Higashi-Kashiwazaki fields) with well flow rates at 5 to around 12 MMscfgd plus 100-200 bpd of associated condensate whilst recoverable field sizes can be >1 Tcf gas and 50 MMbbls of condensate. Porosities in these volcanic reservoir intervals average around 15% whilst permeabilities are generally in the range of 1 to 10 mD. Rapid quenching of the lavas during eruption onto the sea floor led to brecciation and primary fracture formation coupled with the development of primary vesicular and vuggy porosity formed through the escape of volatiles. Subsequent secondary porosity and permeability development involved a complex interaction of the following processes devitrification, low grade sea bed metamorphism, later hydrothermal alteration and even later tectonic fracturing. The diagenetic history of these volcanic reservoirs is complex and they show marked lateral and vertical variations in rock type, mineralogy, degree of alteration and the degree of fracturing all of which make reservoir quality difficult to predict.