

REPUBLIC OF SOUTH AFRICA

PETROLEUM POTENTIAL OF THE KAROO BASINS



The Karoo Basins

The Karoo basins of southern Africa record 100 million years of sedimentation in the heartland of the supercontinent Gondwana, in a range of depositional environments. The erosional remnants of the Main Karoo Basin cover approximately 700 000 km² of southern Africa today (see map overleaf), and together with sediments in subsidiary Karoo-aged basins, these rocks play host to the majority of South Africa's onshore fossil fuel reserves.

Following initial petroleum exploration in the Karoo Basin during the 1960s and 1970s, the focus of exploration activities eventually shifted offshore, due to the perceived low potential for large conventional oil plays onshore. However, the global success of recent technological developments (particularly reservoir fracturing and horizontal drilling) in recovering petroleum from low permeability reservoirs, combined with the emergence of natural gas as an economically viable fossil fuel, has led to renewed interest in the petroleum potential of Karoo sediments, and the emergence of the Karoo Basin as an important exploration target in South Africa.

Current petroleum exploration activities in the Karoo are focused on three unconventional play types: shale gas, coalbed methane and biogenic gas, although the potential for conventional hydrocarbon plays also exists.



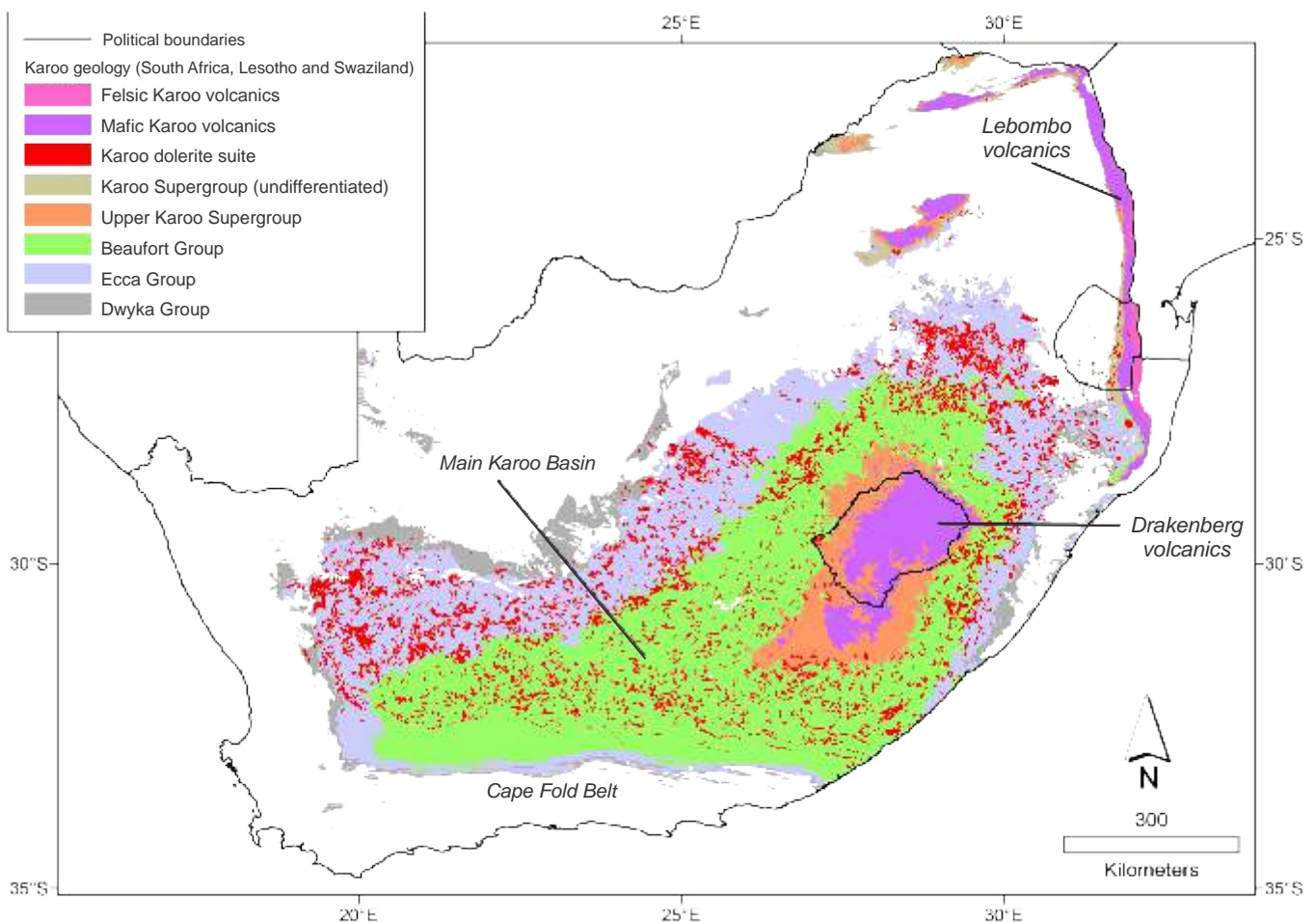
Shale gas

Gas shows were discovered in the southern Karoo several decades ago, and are indicative of an active petroleum system. Whilst shale gas exploration in the Karoo is still in its infancy, the limited available data suggests that the Karoo Basin has good shale gas potential.

The Whitehill Formation of the Ecca Group in the southern Main Karoo Basin is of particular interest, and satisfies all the basic requirements for a successful shale gas play: it is rich in organic matter, it is thermally mature, it has a high silica content and it is deeply buried. Geophysical surveys (e.g. Branch et al. 2007) and legacy well data also suggest stratigraphic continuity for the Whitehill Formation. On the other hand, there are geological complexities in the basin that may present challenges for

successful shale gas exploitation, including the presence of numerous fractured dolerite dykes and sills and the existence of carbonates at some stratigraphic levels.

The shale gas resource of the Karoo Basin is currently unknown, due to the scarcity of relevant geoscientific data, but preliminary model estimates of the technically recoverable resource range from ~30 Tcf to ~500 Tcf (Decker, 2011; Kuuskraa et al., 2011). A significant uncertainty in estimating the size of the resource is gas content, and favourable flow rates are required for exploitation of the potential shale gas play in the Karoo to be economically viable. A major investment in the infrastructure of this remote and arid region of South Africa will also be required.



Above: Geological map of the Main Karoo Basin and surrounding Karoo-aged sedimentary sub-basins and volcanic outliers in South Africa, Lesotho and Swaziland, modified from Vorster (2001). Opposite page: SW-NE schematic cross section of the Main Karoo Basin, according to a foreland basin model (e.g. Johnson et al., 1997).

Biogenic gas

For decades, the methane encountered in underground gold mining of the Archean Witwatersrand Basin in the Free State and Evander gold fields was regarded only as a mine explosion hazard and was flared in large quantities accordingly. Hugo (1963) discusses the early record of CH₄ and H₂ emitted from these underground mines and from the associated gold exploration boreholes.

Gas encountered within the coal-bearing Karoo strata in the region is in fact believed to have migrated from the underlying Witwatersrand Basin. The Witwatersrand methane, in turn, is considered to be biogenic in origin (Ward et al., 2004), and is thus constantly replenished. This former mining hazard may therefore become a potentially renewable future energy source for South Africa.

A considerable number of academic researchers and exploration companies have been investigating if the methane can be turned to commercial advantage. Most recently, an application for a gas production right has been granted in the Free State.

Given the unusual nature of this unconventional biogenic play, it is not possible, as yet, to quantify the volume of the technically recoverable gas resource. However, local gas shows at surface have been known to burn for years without showing any evidence of depletion.



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