The Siberian Platform occupies an immense area of eastern Siberia (Fig. 13). It consists of an Archaean and Lower Proterozoic basement overlain by Riphean (Middle to Upper Proterozoic) to lower Palaeozoic and younger strata. Nine significant oil and gas fields have been located in Vendian (latest Proterozoic) and Cambrian reservoirs. Total recoverable reserves are uncertain at present, but Meyerhoff (1979: AAPG Memoir 30, 225) quoted total reserves of 17.3 Tcf of gas and 435 million bbl of oil and condensate for three of the fields. As part of BMR’s current interest in the petroleum potential of the Precambrian of the McArthur Basin (BMR Research Newsletter 3, 1–2), an organic geochemist from BMR visited the Soviet Union to gain an insight into the conditions of formation and preservation of petroleum in the Siberian Platform as a guide to the possible occurrence of Proterozoic petroleum in Australia. This report briefly discusses the petroleum geology of these very old rocks.

Structure and sedimentary cover

The platform comprises a series of regional arches and domes (anteclises) and basins (synclises). The petroleum occurs in the Nepa-Buotobin Anteclise (VI, Fig. 13). The sedimentary cover varies in thickness from 2 km in the anteclises to 14 km in the synclises. The Baikalian Foldbelt to the south of the platform contains Proterozoic rocks that were later deformed in middle Palaeozoic time.

Riphean carbonate and terrigenous rocks exceed 5 km in thickness on the margins of the platform, and also occupy narrow rifts on the south and southwest sides of the platform but are absent from some anteclises. In the pre-Baikalian Trough (VII, Fig. 13) the upper part of the Riphean sequence contains up to 500 m of organic-rich shale and carbonate (TOC values 3.5 to 5%), and lumps on to the southern part of the platform.

The Vendian-Cambrian rocks represent the period of maximum transgression of the Siberian Platform, and reach a maximum thickness of 2.5 km. Vendian clastic red beds vary in thickness from 0 to 300 m, and lap on to the Nepa-Buotobin Anteclise from the south, southwest, and northwest. Farther north the Vendian-Cambrian rocks consist of carbonates and some salt beds; these strata are equivalent to and perhaps slightly younger than the Vendian clastic rocks.

The Lower and Middle Cambrian rocks in the southern part of the platform consist of four carbonates, and also occupy the northern part of the platform, but are absent from the Nepa-Buotobin Anteclise. Mesozoic sedimentary rocks rarely exceed 300 m in thickness in the southern part of the platform. Flood basals of Early Permian and Triassic age cover most of the platform, and also occupy the northeastern part of the platform, but are absent from the Nepa-Buotobin Anteclise. Cambrian clastic sedimentary rocks occur sporadically. During the Mesozoic-Cenozoic, the platform was uplifted 1.5 to 2 km in the extreme northwest and 1 km in the southeast.

Major structures occurring in the southern part of the platform during Silurian–Devonian time, when the Baikalian Foldbelt was thrust towards the platform (Folds associated with wrench-faulting form the traps on the northeast part of the Nepa-Buotobin Anteclise. The salt acts as a zone of detachment, since structures in the Vendian to Early Cambrian are not related to those overlying the salt.

Petroleum geology

The oil and gas fields lie at depths of 1.5 to 2.5 km. The main reservoirs are Vendian sandstones, but some overlying carbonates (Vendian-Cambrian) are also productive. Traps in the southwest are formed by up-dip pinch-out of the Vendian sandstones (e.g., Markova Field; 1, Fig. 13). Farther northeast, Vendian reservoirs occur in anticlines (e.g., Sredne-Botoupininskoe Field; 6, Fig. 13). The traps in carbonates are produced stratigraphically, and rely on preservation of patches of porosity in organic-framework carbonates.

Vendian clastic reservoirs are mainly coastal marine bars. Some alluvial fans lower in the Vendian clastic sequence are also productive. The organic-rich marine sands have average porosities of 15%, and average permeabilities range from 300 to 600 md.

In the alluvial-fan reservoirs have average permeabilities of around 100 md. Carbonate reservoirs consist of dolomitised stromatolites, but the cavernous porosity is generally filled with salts; intergranular porosities are of the order of 8 to 10%, and permeabilities average 300 md.

The tectonic subdivisions (I–IX) of the Siberian Platform, and locations of oil and gas fields (I–8). I, Anabar Anteclise; II, Tunguska Synclise; III, East Yenisey Terrace; IV, pre-Sayan–Yenisey Synclise; V, Angara–Lena Terrace; VI, Nepa-Buotobin Anteclise; VII, pre-Baikalian Trough; VIII, Vilyuy Synclise; IX, Aldan Anteclise. The Baikaloff Belt (X) lies outside the Siberian Platform.

In the southern part of the platform, the maximum depth of burial of the Vendian-Cambrian section was about 2 to 3 km, during the Ordovician. About 0.5 km of the section has been removed by erosion. Vendian rocks in the oilfields are at the late stage of oil generation. The source for the hydrocarbons is the organic-rich Riphean rocks lying on the southern slope of the platform and in troughs within the platform. At the present time these rocks are in the late stages of catagenesis. Accumulations of pyrobitumen, and fossil gas-oil contacts, represent the remains of exhumed oilfields in Riphean rocks in the exposed parts of the pre-Baikalian Trough.

A first stage of oil generation probably occurred in Late Proterozoic to early Palaeozoic time. Oil was trapped in the Vendian and Riphean sediments, and some migrated up-dip to the crest of the Nepa-Buotobin Anteclise. The continued burial and folding of the Baikaloff Belt in the middle Palaeozoic induced further catagenesis and the destruction of previously formed oilfields on the south of the platform to form pyrobitumen, and resulted in gas generation. Gas-condensate and light oils migrated ahead of the maturation front to the present-day locations.

Factors contributing to petroleum occurrence in the Siberian Platform

1. The southern ramp of the platform faced an actively subsiding trough containing organic-rich sediments. It was ideally placed to receive hydrocarbons migrating out of the trough.

2. The platform, marginal to the trough, provided the shallow-water conditions for the formation of high-quality reservoirs, and provided a primary trapping configuration in the form of up-dip pinches.

3. The platform has remained relatively stable over time, and has not been deeply buried. The reservoir hydrocarbons were not destroyed by thermal processes, in contrast to those in the trough to the south.

4. The reservoirs are capped by evaporites that have maintained a tight seal over the hydrocarbon reservoirs during subsequent tectonic movements. The salt has also acted as a detachment zone protecting the reservoirs beneath from severe disruption.

5. The oilfield area was not involved in the vulcanism that has probably destroyed oilfields in the northwestern part of the platform.

The petroleum accumulations in the Siberian Platform represent a remnant of a much more extensive petroleum province that has been destroyed by subsequent events. The preservation of the petroleum geology of these very old rocks suggests future exploration in the Australian continental shelf.

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Extensional structures

The extensional structures (continued from p. 10) regional folding is north to north-northeast, at a high angle to the strike direction of the early imbricate faults. This indicates that the early extensional direction was in a southerly or southwesterly direction, and that detachment faults formed down-section to the present-day structures. The presence of these features within the Mitakoodi Quartzite is strong evidence of a regionally important early brittle deformational event affecting a large area of the Mount Isa Intrusions. The presence of similar structures 25 km to the west in the Alligator syncline, discovered and mapped by C. Pascich in 1984–86, and evidence of thinning of the Argylla Formation there across a zone of intense deformation, suggest an extensional origin for that structure. The main detachment surface in the Mitakoodi Quartzite may correspond to the Shinfield deformed zone, and may serve the Argylla Formation to cause the stratigraphic thinning and downwarping of the underlying Corella Formation into the syncline structure now preserved as the Duchess Belt (Fig. 12).

Age of extensional structures

The extensional structures affect the granites of the Duchess Belt which have been correlated with 1740 Ma granites to the north and are older than the earliest compressional event (minimum age, 1620 Ma). The event probably predates the deposition of the younger sedimentary sequences of the Mount Isa Inlier, such as the 1670–Ma Mount Isa Group, and may have important implications regarding late basin development and crustal thinning in the Mount Isa region.

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