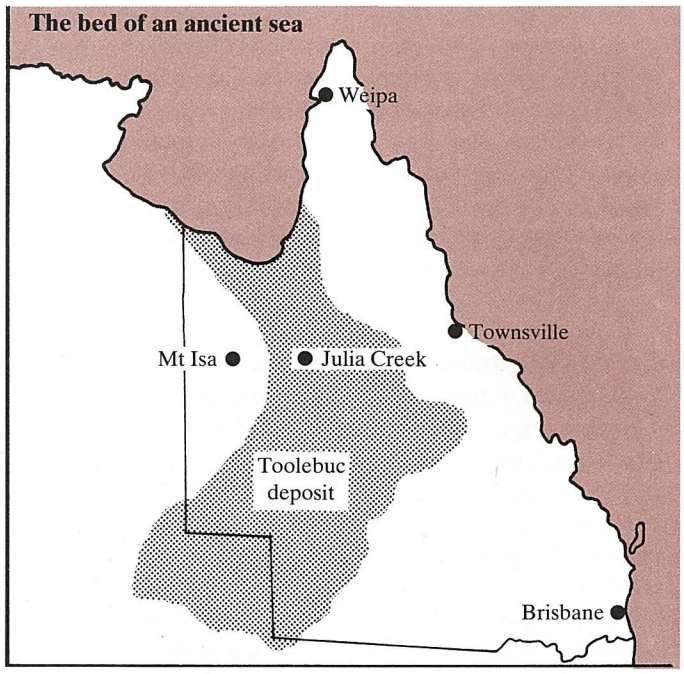
Research improves the economics of oil shale



The Toolebuc oil shale formation is the bed of an ancient sea. The most accessible part is near Julia Creek.

Research into the technology of processing Julia Creek oil shale has improved the economics of the process, bringing closer the day when CSR Limited can turn its lease into an oil-producing enterprise.

The company has title to the most accessible part (the Julia Creek area in central Queensland) of what is probably the largest deposit of oil shale in the world. The whole Toolebuc deposit — the bed of an ancient sea — stretches from the Gulf of Carpentaria to the New South Wales border and may, according to the Bureau of Mineral Resources, contain shale equivalent to at least one million million barrels of oil — about three times the known oil reserves of the Middle East.

In the Julia Creek area, open-cut reserves of shale are sufficient to produce about 5000 million barrels of oil, equivalent to three times the current known oil reserves in Bass Strait. The shale is medium-grade, yielding about 70 litres of oil per tonne and sufficient gas for refining the oil.

A feasibility study conducted by CSR in 1980 estimated that the capital cost of a project to produce about 100 000 barrels of refined shale oil each day was close to $6000 million. This plant could supply about one-sixth of Australia's needs for at least 35 years.

At that time, estimates put the cost of the oil at about $U.S.42 per barrel, at least $10 more than the landed price of Saudi Arabian light crude. Since then, new retorting technology devised by the CSIRO Division of Mineral Engineering has closed that gap but, of course, in the interim the real price of oil has fallen.

In collaborative research with CSR, the Division has demonstrated that spent shale from the retorts (in which the shale undergoes heat treatment to produce crude oil and gas) can be burnt in a fluidized-bed combustor to provide process energy. Previously it had been thought that extra raw shale would need to be mined to provide the heat.

The scientists found that the Julia Creek material is unique. Noteworthy are the high proportion of limestone (more than 40%) and its good mechanical strength — properties that remained unexploited when CSR first entertained using the American TOSCO-II retorting process. (In 1980, this process — TOSCO stands for The Oil Shale Company — was the only one to have reached the demonstration-plant stage.)

The key to the new approach is to use a fluidized-bed combustor to burn spent shale. After retorting, half the energy content remains in the spent shale and although this residue is a very low-grade fuel, a fluidized-bed combustor, by floating it on an updraft of air, can get it to burn.

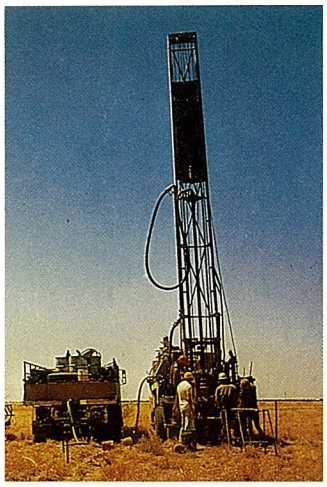
The heat recovered from the flue gases in a waste-heat boiler can be used to generate power for mining, crushing, and conveying. Furthermore, the hot shale ash, which forms mechanically strong particles, can be drawn off from the fluidized bed and used for heating fresh shale by mixing the two together in the retort. This is much simpler than heating ceramic balls to carry the heat in a special heat cycle, as the TOSCO-II process does.

Lime in the ash contributes heat too when it reacts with carbon dioxide and water in the retort. Lime is also a useful scavenger of obnoxious hydrogen sulfide gas generated in the retort along

with desirable hydrogen (the shale oil contains 2% sulfur).

In laboratory tests, gas from a 50:50 mixture of oil shale and shale ash contained less than ·002% hydrogen sulfide, compared with about 9% in the gas produced when retorting fresh shale by itself.

The new process doubles the amount of hydrogen produced, and this is a valuable result because hydrogen is required to process the shale oil. Normally it would be converted at the mine to synthetic crude oil, but at Julia Creek, because so much hydrogen would be available, the syncrude could be further processed to refined petroleum. This would increase the product's value by 30–35%, and it could be piped a shorter distance — to outlets at Townsville rather than to refineries at Brisbane — saving $2 a barrel.



Test drilling at Julia Creek.

Reductions in the cost of retorts, gas cleaning, and hydrogen production plants could lower oil prices by nearly $3 a barrel. Avoiding the mining of 9 million tonnes a year of extra shale (82 million tonnes instead of 91 million) for process heat could save up to $2 a barrel, and generating power rather than purchasing it could save $1 a barrel, according to the CSR study.

Thus, total potential savings lie between $4.50 and $6 a barrel.

At present CSIRO and CSR are continuing work to optimize the process. The retorting side is being tested at CSR's continuous half-tonne-a-day pilot plant, and plans for one 50 times bigger are being drafted. The company considers that the project will provide a large local supply of petroleum by the mid 1990s.

Andrew Bell

A process concept for Julia Creek oil shale retorting. O. Sitnai. *Papers, First Australian Workshop on Oil Shale, Sydney, May 1983.*

Other oil shale studies

A large number of research and engineering organizations, both in Australia and overseas, are working on Queensland's massive oil shale deposits — those along the coast as well as the Toolebuc one. Among them are the CSIRO Division of Mineral Engineering, and the following five other CSIRO Divisions.

DIVISION of FOSSIL FUELS Scientists are studying the fundamentals of the nature and organic content of oil shale, together with data obtained from instruments lowered down drillholes. The aim is to determine the factors that influence the extent and richness of a deposit so as to improve exploration methods. A range of geochemical methods are also being developed to compare the likely oil yields of various deposits. Supported by Esso Australia, scientists are using nuclear magnetic resonance to study the properties of Rundle oil shale, and with the help of NERDDP and Esso, they are studying the possible fate of metals that may get into local rivers as a result of shale mining.

DIVISION of ENERGY CHEMISTRY Research under way seeks to understand the chemical composition and properties of Australian oil shales. Using electron spin resonance and thermal analysis, scientists are determining how the oil shale breaks down when retorted. Others are studying several organic and metal-organic compounds found in shale to see how these could have originated and whether the compounds, if leached from spent shale, might harm human health or the environment. The toxicity of pollutants in effluents from oil shale mining and processing is also being determined.

Work is proceeding with a demonstration-scale retort (10 kg per hour) to compare and optimize the retorting of Australian oil shales. Sophisticated equipment allows study of correlations between properties of shale oils and properties of the original shale. In collaboration with CSR, the Division is also investigating the upgrading of Julia Creek shale oil to transport fuels.

DIVISION of MATERIALS SCIENCE Studies here cover the production of high-grade refinery feedstocks or diesel fuel from shale oil by treating it with hydrogen. Scientists are developing novel catalysts to increase the efficiency of this step.

DIVISION of MINERALOGY Scientists are examining the mineral components of oil shales to improve predictions of how these will behave under different processing conditions.

DIVISION of MINERAL CHEMISTRY The Division is conducting research supported by Esso Australia to establish the thermal and thermodynamic properties of Australian oil shales and processing products, particularly of Rundle oil shale. The information is needed for the design of industrial-scale processing plant.