

# INTRODUCTION

## BASIN OUTLINE

The Cooper Basin forms the most significant element of Australia's largest onshore oil and gas province. Since the discovery of natural gas at Gidgealpa in 1963 and oil at Tirrawarra in 1970,  $229 \times 10^9 \text{ m}^3$  (8.2 tcf) of recoverable raw gas and  $6.9 \times 10^6 \text{ kL}$  (43.9 mmstb) of recoverable oil<sup>1</sup> have been found in South Australia at 1 January 1998. A total of  $129 \times 10^9 \text{ m}^3$  (4.6 tcf) of gas and  $4.6 \times 10^6 \text{ kL}$  (29.1 mmstb) of oil have been produced to date. The Tirrawarra Field contains 80% of known oil reserves; one-third of South Australia's Cooper Basin gas reserves are in the Moomba and Big Lake gas fields. Pipelines supply Cooper Basin gas to Adelaide and Sydney as well as a number of regional centres, ethane to Botany Bay, and a liquids pipeline carries oil, condensate and liquefied petroleum gas (LPG) to Port Bonython.

The Cooper Basin is a Late Carboniferous to Middle Triassic, non-marine sedimentary basin which underlies the desert region of northeastern South Australia and South-West Queensland. One-third of the basin ( $35\,000 \text{ km}^2$ ; 13 500 square miles) is in South Australia; the unconformity at its upper surface varies in depth from 970 to 2800 m while the base of its deepest trough reaches ~4400 m below sea level. As shown in Figure 1.1, the Cooper underlies the southwestern Eromanga Basin (or Great Artesian Basin, a major water resource). The Eromanga Basin is Jurassic to Cretaceous in age and contains a number of small to medium sized oil fields. There is one small population centre at Moomba (a fly-in fly-out camp) which is the hub of the region's gas treatment and gas and oil pipelines. A map of oil and gas fields and pipelines is shown in Figure 1.2 while infrastructure is described more fully in Chapter 4.

## SEISMIC AND WELL COVERAGE

Based on 40 years of exploration and development, including drilling 1200 wells with an average success rate of ~30%, leading to the discovery of 121 gas and 25 oil fields (at 31.12.97), it may seem reasonable to assume that the Cooper Basin in South Australia is a mature petroleum province. However, although this assumption may be true for petroleum production licence areas (PPL; ~8000  $\text{km}^2$  (3100 square miles) or <25% of the basin in South Australia), it

<sup>1</sup>Number refers to Cooper oil only. Total recoverable oil (Cooper and Eromanga) in SA is  $17.5 \times 10^6 \text{ kL}$  (110 mmstb). See Chapter 14 for recovery factors.

does not apply to the main portion of the Cooper and overlying Eromanga Basins which Primary Industries and Resources South Australia (PIRSA) considers to be relatively underexplored. Within PPLs (excluding those in the sparsely drilled Nappamerri Trough, Fig. 2.6) there are  $7 \text{ km}^2$  (1750 acres) on average surrounding each well drilled. In contrast, outside PPLs, there are  $66 \text{ km}^2$  (16 500 acres) on average surrounding each well drilled. In simple terms, the Cooper Basin is about nine times more poorly explored outside production licences than within them, based on well density.

The distribution of seismic lines has become increasingly focused over the past four decades as oil and gas discoveries demanded more accurate structural delineation for locating appraisal and development wells. As shown in Figure 1.3, ~80 000 km of two-dimensional (2D) seismic have been recorded and, in the past six years, 15 three-dimensional (3D) surveys. Figure 1.4 provides a

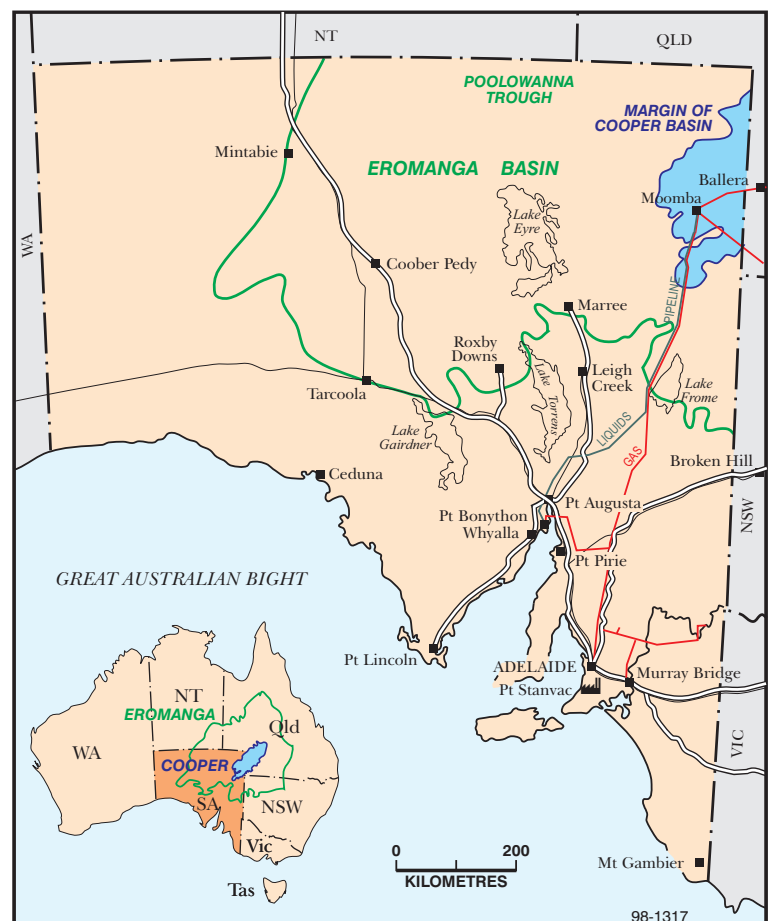


Fig. 1.1 Location map of Cooper and Eromanga Basins in South Australia.

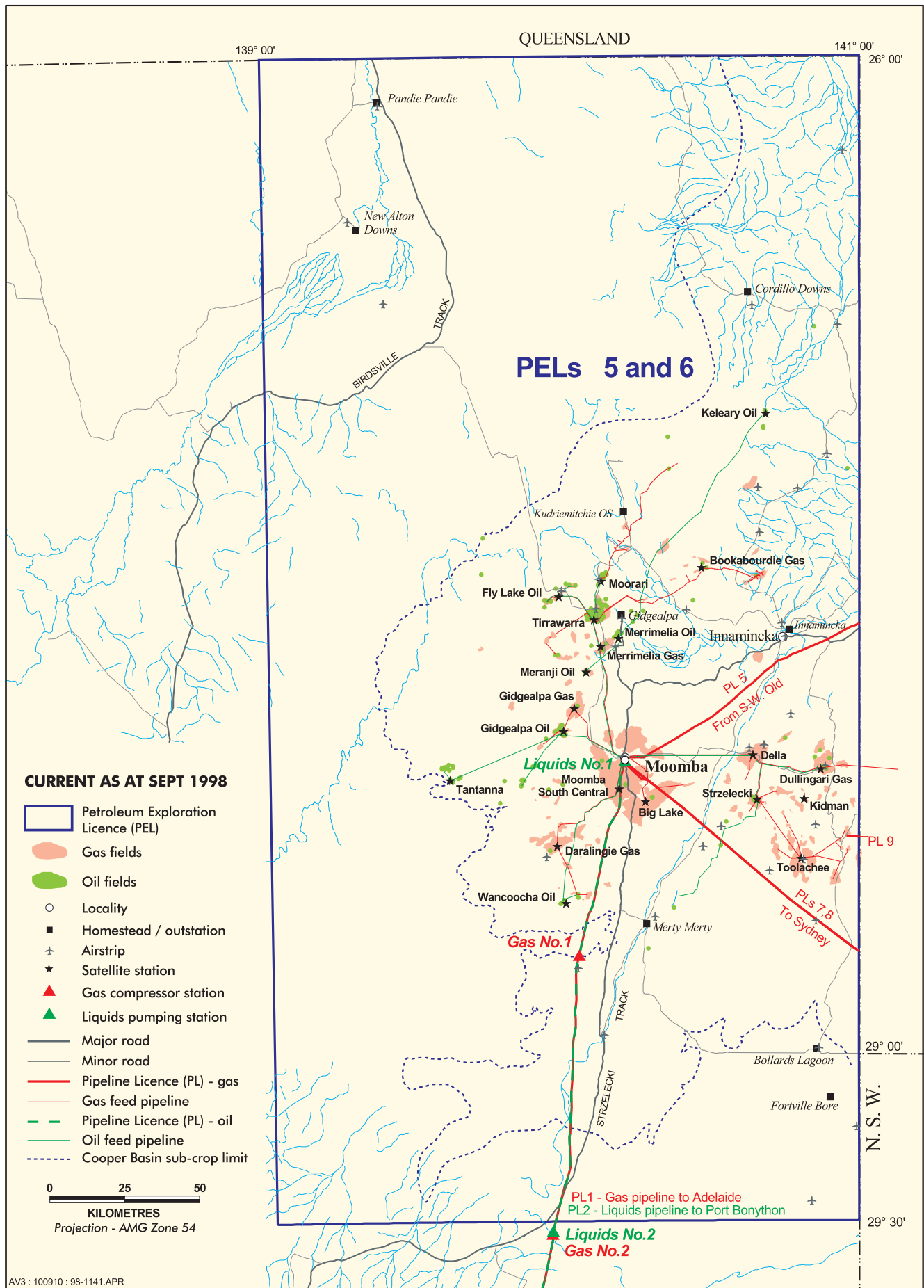


Fig. 1.2 The Cooper Basin in South Australia showing locations of oil and gas fields and major pipelines.



breakdown of seismic line distribution in each of the four decades since recording began. Seismic lines recorded between 1957 and 1969 were of a reconnaissance nature and relatively long and widely spaced (Fig. 1.4a). In the decade 1970–79, the Cooper Basin margin became increasingly well defined and seismic surveys concentrated on locating major gas-bearing structures within the basin (Fig. 1.4b). The discovery of Mesozoic oil in 1978 in good quality Eromanga reservoirs and rising oil prices in the early 1980s encouraged completion of an oil and gas liquids pipeline from Moomba to Port Bonython (Fig. 1.1). Closely spaced seismic grids were recorded in this period to locate subtle Mesozoic structural traps (Armstrong and Barr, 1986). During the 1980s long lines were also recorded across the western and southwestern Cooper Basin margin to locate basin edge stratigraphic plays (Stanmore and Johnstone, 1988), and Australia's first 3D survey was recorded at Cuttahirrie (Fig. 1.4c).

In the past decade little seismic has been recorded outside the Cooper Basin but coverage inside increased markedly with the recording of 3D surveys totalling 3100 km<sup>2</sup> (1200 square miles), notably at Moomba, Toolachee, Dullingari–Burke, Merrimelia and Pondrinie, shown by the solid red areas in Figure 1.4d. At the same time, modification of parameters used in 2D seismic recording has led to an improvement in bandwidth at the high frequency end with a corresponding increase in resolution (Hughes and Fitzgerald, 1995).

Seismic exploration over the past 40 years has focused downward from regional lines, through grids for prospect definition, to 3D for prospect element delineation. There has been a recognition that not only are undrilled prospects relatively small, but prospect elements such as fluvial channels which cross large structures are also small (e.g. Mackie *et al.*, 1995). Reservoirs are stacked vertically but many tend to be laterally restricted and have a stratigraphic trap component. From one point of view it could be concluded that focusing on play elements in particular areas leaves other areas relatively lightly explored.

## FUTURE OPPORTUNITIES

Several methods of assessing undiscovered Cooper Basin reserves are described in Chapter 14. Middle of the range estimates suggest that 60 229 x 10<sup>9</sup> m<sup>3</sup> (2 tcf) of recoverable gas and 5.4 x 10<sup>6</sup> kL (34 mmstb) of recoverable oil remain to be discovered. While newly discovered fields tend to be small ( $\leq 280 \times 10^6$  m<sup>3</sup> or 10 bcf), the Cooper Basin Joint Venture has made gas–condensate discoveries of medium size in the last two years e.g. Goyder 2 (Santos Ltd, 1997a), Dorodillo 1 (Santos Ltd, 1997b) and Cabernet 1 (Santos Ltd, 1998).

Santos Ltd has held exploration tenements over the Cooper Basin continuously since 1954. Petroleum Exploration Licences (PELs) 5 and 6 were originally more extensive (see Ch. 2), but relinquishments have reduced the area to ~73 000 km<sup>2</sup> (~28 190 square miles). Farmins were initially the method of obtaining an interest, but company acquisition has now become the most common means. However, this is about to change following the expiry of PELs 5 and 6 in February 1999. Both business and governments are now rising to the challenge of making Australia more competitive. The South Australian

Government has decided that acreage in the Cooper Basin region, exclusive of production (and potentially retention) tenements will be made available for competitive bidding on expiry of PELs 5 and 6. In order to facilitate this process, the legislative regime is under review, data issues are being addressed and the necessity of access to existing processing plant and associated infrastructure is being considered and data and land access issues are being addressed.

## Regulatory regime

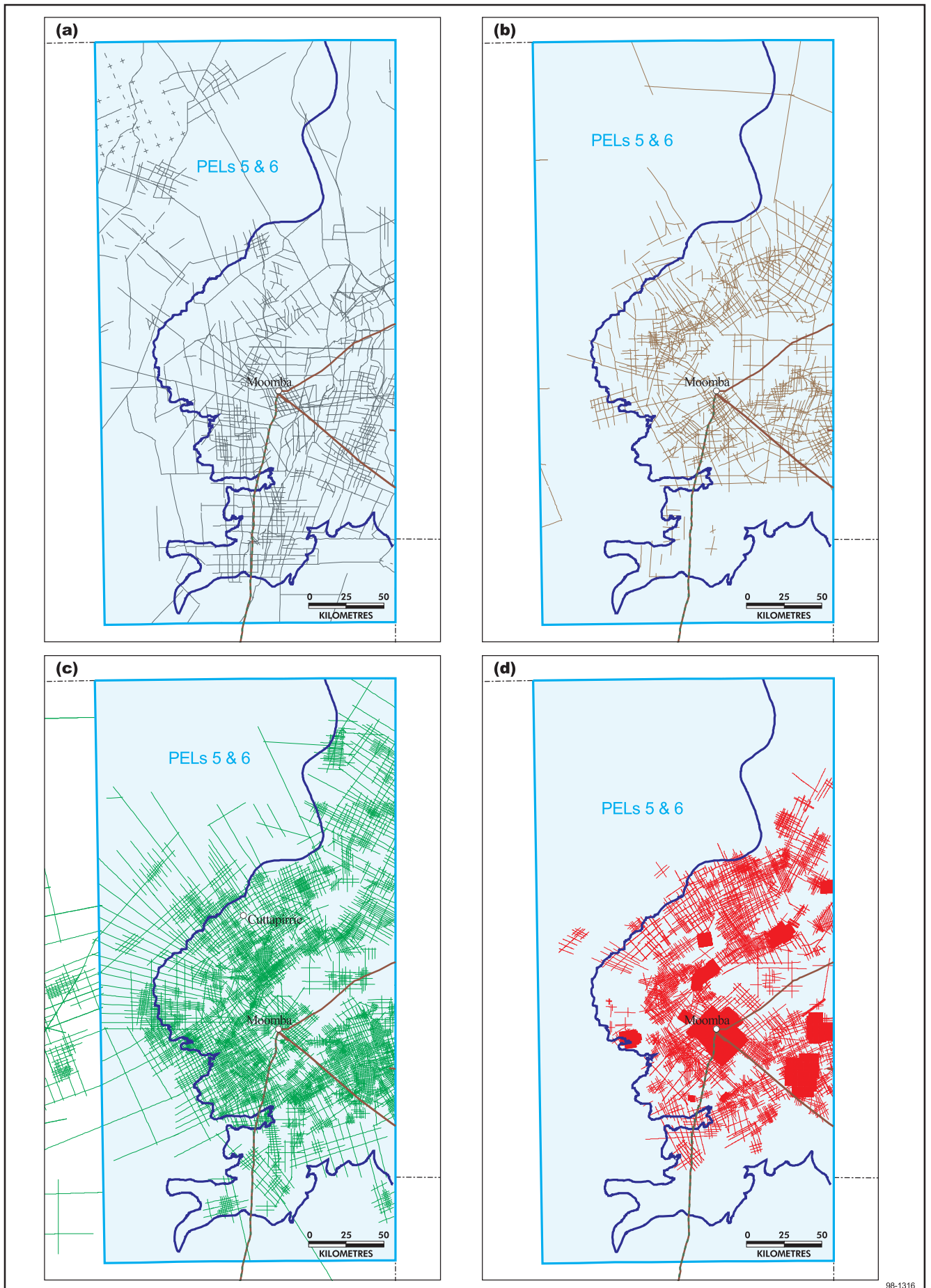
- A green paper on a review of the *Petroleum Act 1940* was released in mid 1997.
- A Bill for a new Petroleum Act is scheduled to be introduced into Parliament during 1998.
- Objective regulation is being implemented with the willing assistance of industry and following valuable contributions from community interest groups.
- Amendments to the *Petroleum Act* and other legislation with regard to native title issues are under consideration.

## Access to infrastructure and markets

- An analysis has been released of the estimated cost of independent processing and transporting petroleum compared to tolling through existing facilities (see Ch. 13).
- Access provisions under the federal *Trade Practices Act 1974* possibly apply to facilities such as the Cooper Basin infrastructure and there is pressure to clarify this issue.
- The South Australian Government considers upstream access a State issue and would prefer that industry introduces self-regulation via a public code setting out conditions under which gas would be tolled through existing petroleum processing and transportation facilities and including binding arbitration in the event of a dispute.
- A right of access is already provided to sales gas transmission pipelines in South Australia and legislation implementing the agreed national pipeline access regime is now in place.
- Direct producer–consumer contract negotiations have been facilitated and a number of new contracts recently negotiated.

## Access to data

- Extensive verified digital databases, including well, core analysis, production statistics etc.
- GIS data which include topography, geological mapping, environmental data, tenements, well locations etc.
- Seismic shotpoint database (>80 000 km recorded in the Cooper Basin), well log database (on CD-ROM), and a regional seismic interpretation (eight horizons, contours, isopachs, time and depth maps, and images).
- Both field and processed seismic tapes are being transcribed onto Exabyte (with the latter edited to facilitate work station loading).



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Fig. 1.4 Cooper Basin seismic coverage (a) 1957-69, (b) 1970-79, (c) 1980-89, (d) 1990-97.

- Systems have been implemented to safely store and rapidly retrieve physical data items (including cores, cuttings, seismic sections and seismic tapes).

### Access to land

- South Australia has a multiple land use policy with exploration and production activities permitted (and extensively occurring) in a number of reserves under the *National Parks and Wildlife Act 1972*.
- A Bill for a new Petroleum Act provides for regular availability of acreage for competitive work program bidding and improved certainty of tenure provisions.

The opening of the Cooper Basin to competitive bidding will provide a unique opportunity for explorers. Advantages include established infrastructure and markets, proven play concepts, high wildcat discovery rates, access to detailed data and a Government with a proven track record of facilitation of responsible petroleum exploration and development.