BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1983/33

RECORD

MURRAY BASIN HYDROGEOLOGICAL PROJECT

PROGRESS REPORT 10

for half year ending 30 September 1983

compiled by

W.J. Perry

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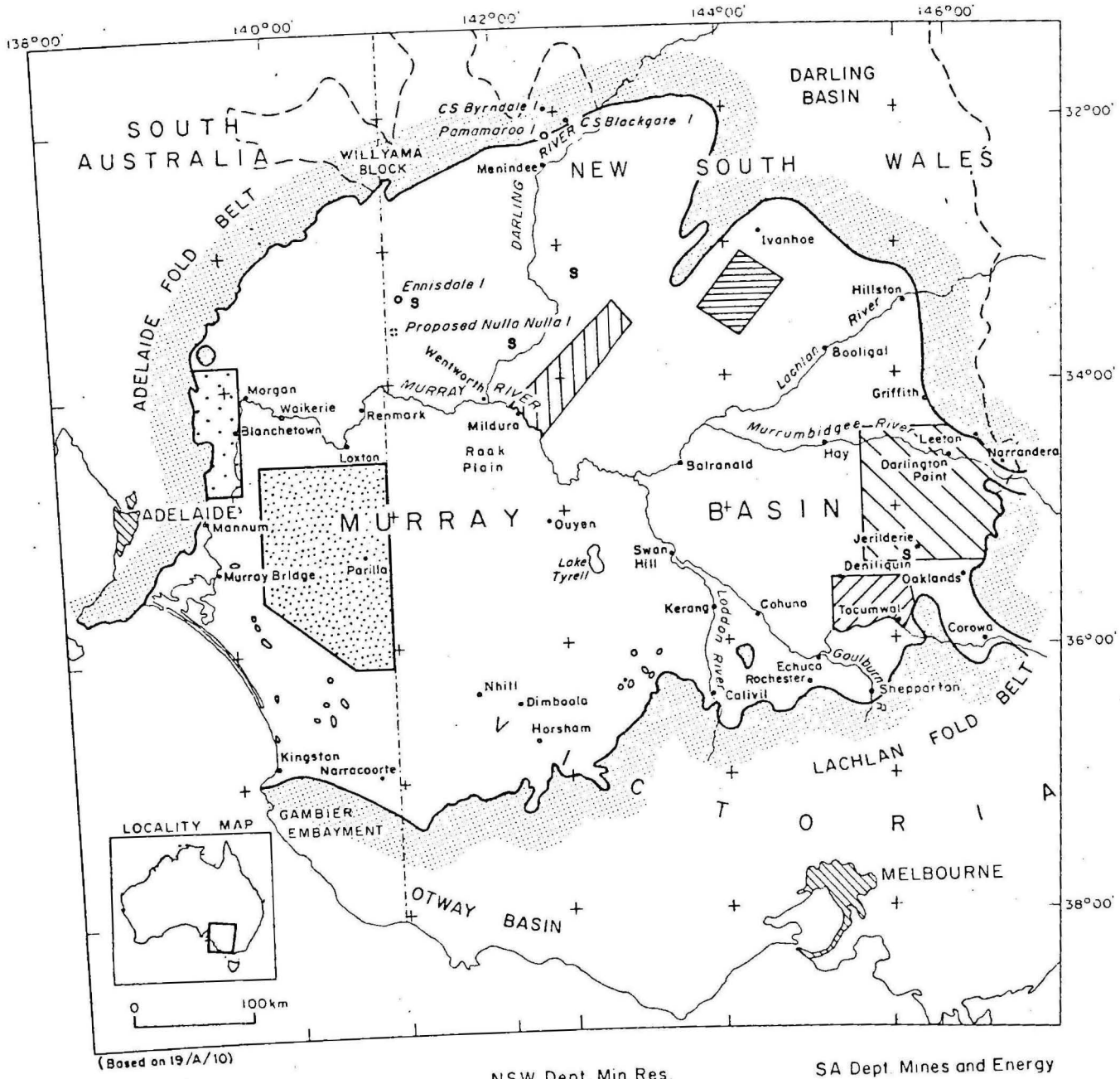

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Fig. 1. Locality diagram

INTRODUCTION

The Steering Committee met in June. An important aspect of the meeting was a discussion on the hydrogeological phase of the Project, which at BMR formally began at the beginning of July. It was considered that the hydrogeological assessment should include: the acquisition from State Authorities of all available data, which would then be entered into a BMR data base designed for the Project; the preparation of an initial report assessing the available data and recording deficiencies, together with accompanying maps including the following: 1:1 million scale water table and potential contours for the three/four hydrostratigraphic units; 1:1 million scale salinity variations including specific ions, for the three/four hydrostratigraphic units; 1:2.5 million scale maps depicting amount of water abstracted-added per unit area, recharge-discharge areas, distribution and type of salting, streamflow-groundwater interactions, and distribution of aquifer parameters for a 7-layer hydrogeological model (aquifers and aquicludes).

Compilation of the 1:1 million scale geological map of the basin continued at BMR.

PROGRESS REPORTS

WATER RESOURCES COMMISSION OF NEW SOUTH WALES

by

D.R. Woolley

1. Drilling

The first bore at Mallee Cliffs, the bedrock high site, was drilled to a total depth of 242 metres. It encountered:-

0	-	38 m Parilla Sand
38	-	119 m Geera Clay
119	-	232 m Duddo Limestone
232	-	242 m Devonian ? Quartzite

Two zones, one in the Parilla Sand the other in the Duddo Limestone, will have piezometers installed.

Samples were forwarded for micro-palynological examination to V. Scheibnerova, Dept of Minerals and Energy, N.S.W.

The second bore - 8 km to the southeast of the first, which is thought will encounter Renmark Group sediments and have a total depth about 400 metres, will be commenced when a suitable drilling rig is available.

Seven bores in the Tocumwal-Deniliquin area are planned to be commenced in the next half year. They will be used to monitor the good quality groundwater associated with Tertiary sediment aquifers known to supply large yields of good quality groundwater to suitably constructed bores.

2. Geophysical Surveys

A total of 35 km of seismic refraction traverses and 13 electric resistivity soundings were carried out during the period both in the Mallee Cliffs, Lachlan and Murrumbidgee groundwater areas of the Murray Basin.

3. Water Sampling

The water sampling program in the N.S.W. part of the Basin is completed except for a small area south of Ivanhoe which is to be completed by the end of 1984.

4. Water Level Recording

Monitoring of water levels continued in the Commission's observation bore network in the eastern part of the Basin.

5. Clay Analysis Samples

A report based on clay samples from 25 bores in the Coleambally-Darlington Point area is currently in a draft stage. It outlines the groundwater hydraulics and hydrochemical changes which occur in the area. The report will be completed by February, 1984.

NEW SOUTH WALES DEPARTMENT OF MINERAL RESOURCES

by

D.H. Probert

1. Coal Exploration

Little activity has taken place during the period. Both Mitsubishi Pty Ltd and Pacific Coal Pty Ltd are continuing geotechnical and mining feasibility studies of coal resources in their authorisations in the Oaklands Area.

2. Petroleum Exploration

Meekatharra Minerals NL is still assessing the results of the 40 km of reflection seismic carried out near Jerilderie No 1 well. The seismic has shown a thicker sedimentary sequence than expected.

BHP Pty Ltd has completed 560 kms of a proposed total of 1000 kms of seismic reflection on Comserv's Darling Depression petroleum exploration licences 247, 248, 250 and 251.

Esso (Australia) Pty Ltd also in association with Comserv has completed three short seismic (reflection) traverses (approx 60-70 km) within PEL's 213 and 214 in the western and northern sections of the Murray Basin. A program of three stratigraphic wells has commenced.

(a) Esso Pamamaroo No 1 was drilled north of Menindee and Pamamaroo Lakes to a T.D. of 799 m. The well was open holed to the base of the Tertiary and fully cored for the remainder of the hole bottoming in Devonian red beds.

(b) Esso Ennisvale No 1 is drilling ahead at 1068 m on the north-western corner of PEL 214. The programmed depth of the hole is 1250 m.

(c) Esso Nulla Nulla No 1 near the South Australian border some 30 km south of Ennisvale No 1 also in PEL 214 will be spudded in during November.

SOUTH AUSTRALIAN DEPARTMENT OF MINES & ENERGY

by

S.R. Barnett

Funds for the 1983/84 rotary drilling program have expired. To date, 13 observation wells have been completed in the Mallee region, of which 8 are monitoring the Renmark Beds confined aquifer. On the western margin, 20 holes have been drilled with 8 completed in the confined aquifer. So far, 140 wells have been drilled.

Observation wells in the riverine tract alluvium are monitoring the response of the water table to the present high river levels.

An observation network has been established in the Mallee region to monitor the effects of large-scale irrigation. This area has been proclaimed under the Water Resources Act, and a regional assessment of the hydrogeology is underway to establish a safe yield for irrigation. A rehabilitation and well discharge test program is planned for the town water supply wells in the area and will provide aquifer parameters for the Murray Group limestone.

STATE RIVERS AND WATER SUPPLY COMMISSION

by

D. Ife

1. Water Table Map - A map of the Shepparton Region showing depth to water table for the month of August 1982 has been prepared.

2. Bore Survey - A survey of piezometers in the Shepparton Region was carried out to provide information on aquifer availability and groundwater salinity.

3. Salt Map - A map of the Shepparton Region showing salt affected land was produced.

4. Regional Drilling - Drilling of exploratory bores continued to an average depth of 25 metres.

5. Groundwater Modelling - Modelling of groundwater flow in the Girgarre area (25 km east of Rochester) was undertaken with a view to determining the rates of infiltration and accession to the water table.

6. Campaspe - Drilling and pump testing was carried out in the Campaspe Irrigation District (Rochester area) to locate shallow aquifers which could be pumped for groundwater control of high water table areas.

GEOLOGICAL SURVEY OF VICTORIA

by

C.R. Lawrence

Action currently being undertaken is modification of modelling of the hydrodynamics of the Campaspe Valley by R. Williamson, incorporating reference to the latest observation bore data.

A draft report on groundwater/salinity of the Victorian portion of the Riverine Plain being prepared by S. Tickell and W. Humphreys is expected to be available early in 1984.

A comprehensive work has been completed by P.G. Macumber on geology, shallow groundwater lakes and geomorphology of the Mallee and Loddon Valley. This report has been submitted as a doctorate thesis.

It shows that in northern Victoria, regional groundwater flow passes northwards from recharge areas in the highlands towards regional discharge zones situated in the lower Loddon Plain and in the Mallee. The principal regional aquifers are the late Tertiary fluviatile valley-fill gravels and sands of the Calivil Formation, now buried beneath 60 m to 80 m of Quaternary sediments, and its down-basin marine equivalent, the unconfined Parilla Sand.

Where groundwater discharges at the surface it affects the geomorphology, the soils, and the vegetation. Groundwater discharge commonly occurs in small salinas and gypsum flats at low points scattered throughout the landscape, or it may appear in the larger groundwater discharge complexes - the boinkers and effluent streams which in the Riverine Plain have a distinct geomorphic and sedimentologic character which distinguishes them from other streams on the plain, also they are invariably brackish or saline.

The locations of the groundwater discharge features in the Mallee are largely determined by structural and topographic influences; however in the Loddon Valley stratigraphic and lithologic variations in and between the regional aquifers have a stronger influence on the development of a regional discharge zone.

The chemistry of the regional groundwaters trends towards a character similar to that of seawater. The strong influence of the regional groundwater flow on the salt lakes of northern Victoria is seen in their hydrochemistry which invariably resembles a concentrated regional groundwater. The chloride and bromide ion concentrations in the lake waters, have provided insight into an annual cycle of halite re-solution, the evaporitic concentrations within the lakes, the hydrologic interactions between salt lakes and the groundwater system.

The regional groundwaters of the Mallee are acidic, with pH values often 4.5 or less. This enables the ready transport of metal ions especially iron from up-basin source areas into the discharge zones. Where groundwater discharges around the perimeter of salt lakes, acid conditions in the spring zone are replaced by neutral conditions at the lake edge, thus providing an important zone for the precipitation of previously soluble ions. Contemporaneous iron oxide deposits of groundwater origin are a common feature of the shorelines of the larger discharge lakes. This process is inferred as being responsible for many similar iron and metallic ore deposits.

The present day structural and stratigraphic framework for the groundwater flow systems of northern Victoria was established during the Tertiary Period and has remained virtually unchanged since that time. During the following Quaternary Period however, there have been major climatically induced fluctuations in water budgets which have left their imprint on the hydrochemistry of the groundwater, and on the geomorphology and mineralogy of the discharge landscapes.

The delicate hydrologic balance within the groundwater system was demonstrated by the rapid expansion in the discharge zone of the Loddon Valley in response to several abnormally wet years during 1973/75, and by the uniform rise is potentiometric heads of the regional Calivil Formation aquifer in the Campaspe Valley since the turn of the century. Within the Mallee Region rises in the water table associated with the unconfined Parilla Sand aquifer have caused the salinization of the lower depressions, also with re-activation of salinas and gypsum flats in areas which were formally grassed

and had a tree cover. The rising water tables now being experienced across northern Victoria and the subsequent salinization of large areas of both irrigated land and dry land, are seen as resulting from increased accessions to the groundwater systems brought about by the removal of trees and the introduction of various agricultural practices following European settlement.

While the present day cycle of salinization is man induced, there is much evidence in the landscape of earlier climatically induced cycles of salinization during times of higher water budgets in the past. The most significant change in water budgets observed in the late Quaternary sequences in the study area was the drying up of Lake Tyrrell at about 32,000 years B.P. when water levels fell about 14 m. The fall in lake levels led to conditions favourable for the formation of lake brines by the evaporative concentration of lake waters; these brines were in turn flushed into the underlying aquifer to gradually build up an extensive groundwater brine body.

Similar high density groundwater brines are found beneath many of the larger salt lakes of north western Victoria, where they strongly influence the interactions between the lakes and the less saline regional groundwaters. The loss of salt from the lakes into the groundwater systems and eventually from the lake basin into the regional flow system is seen as the reason for the virtual absence of any significant salt deposits in the salt lake basins of Victoria.

BUREAU OF MINERAL RESOURCES

by

C.M. Brown & R. Evans

A major activity of the review period has concerned compilation of the 1:1 000 000 geological map of the Basin, following field work undertaken in western New South Wales in August/September 1982. Photo-interpretation of the Cainozoic geology of the Ana Branch, Pooncarie, Balranald, Menindee, Manara, Booligal, Hay, Deniliquin 1:250 000 map sheet areas was completed. In addition amendments were made to the interpretation of the Cainozoic geology of the Ivanhoe, Nymagee, Cargelligo, Narrandera and Jerilderie map sheets. The Cainozoic geology of all 31 map sheet areas in the Murray Basin has now been compiled to a standard format and legend, prior to photo-reduction to 1:1 million scale. Drafting of the Cainozoic geology in the BMR drawing office

commenced during the period. A preliminary total magnetic intensity map, based on existing BMR data (including recently acquired data) was also compiled at 1:1 000 000 scale.

Subsurface data from 476 boreholes in the Naracoorte and Jerilderie map sheet areas were also tabulated during the period and hence plotting of borehole localities and tabulation of downhole stratigraphic information has now been completed for all 27 relevant map sheet areas in the Murray Basin.

A number of microfiche reports recording the systematic aspects of the data synthesis are in preparation and work commenced on the writing of sections of a BMR Bulletin on geology of the Murray Basin. C.M. Brown presented a paper on the Murray Basin (abstract attached) at the twelfth BMR Symposium held in May 1983, Canberra.

Hydrogeological phase

The transcription manual for the hydrogeological data base was written. The Victorian data, in the form of magnetic tapes, was received leaving the NSW section as the only outstanding area. The plotting of bores in the NSW section of the Murray Basin, onto AMG coordinate maps continued. Eight 1:50 000 sheets have been completed, another 8 are nearing completion. Discussions were held with ASO regarding the production of an accurate topographic map of the Basin, at a contour interval of 5 to 10 m.

Sea-level changes and Cainozoic sedimentation in the Murray Basin

C.M. Brown

Recent work by BMR, in cooperation with State Surveys, has resulted in a revised interpretation of stratigraphic relationships in the Murray Basin and leads to the conclusion that fluctuations in supply, preservation, and erosion of sediment in the basin can readily be accommodated by eustatic models. These involve global changes in relative sea-level and related intrabasinal isostatic adjustments associated with sediment loading. The Murray Basin sedimentary record may be subdivided into three and possibly four depositional sequences, each consisting of a package of genetically related formations, separated by surfaces of erosion or non-deposition. The Cainozoic history of the basin has been characterised by slow relative subsidence rates, low rates of sediment supply, and mineral

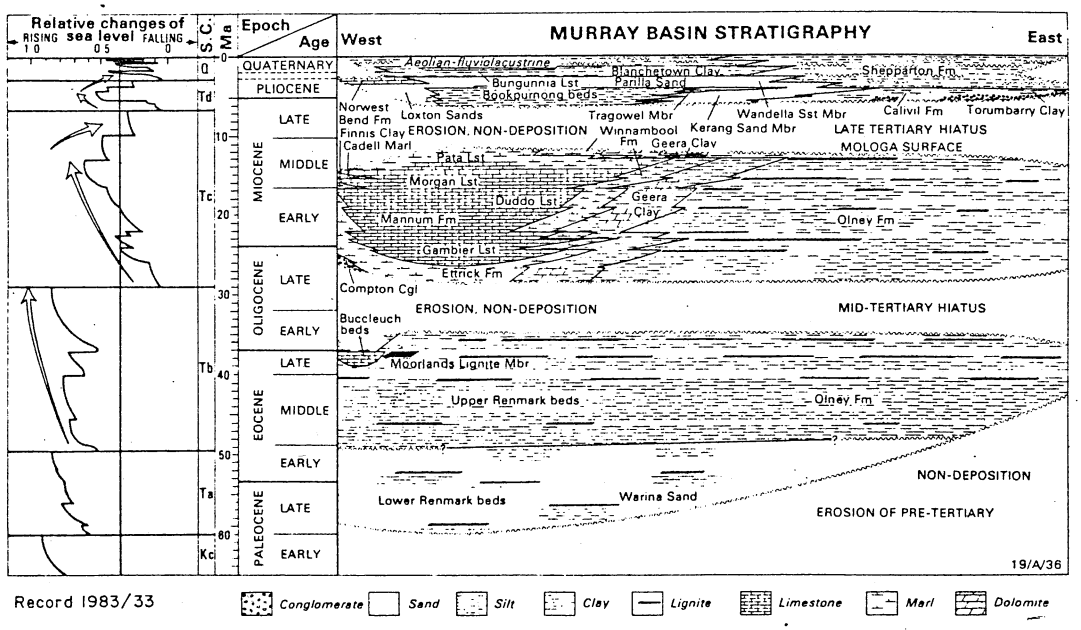

Fig.2. Eustatic interpretation of Murray Basin stratigraphy. Relative changes in sea level shown on the left are from Vail & others (1977)

compaction rates. Framework tectonics provide the primary control on development of the basin; however depositional sequences show an apparently close correlation with the 'second-order cycles' (supercycles) of relative rise and fall in global sea-level as recorded by Vail & others (1977), and Vail & Hardenbol (1979) (summarised in Fig. 2). The Cainozoic history of the basin has been characterized by slow relative subsidence rates, low rates of sediment supply and minimal compaction rates and sediment preservation appears to have been sensitive to superimposed secondary eustatic and palaeoclimatic influences, and to consequent fluctuations in the erosive and depositional potential of the fluvial systems that drain the basin. Laterally extensive intercalations of fluvio-deltaic, paralic, and shallow-marine sediments appear to have been deposited during periods of high global sea-levels, whereas non-preservation because of erosion/non-deposition appears to have occurred during major periods of lowered sea-levels. Jones & Veevers (1982) have proposed an alternative model of tectonic cycles. They interpreted depositional cycles in the Murray Basin to be the erosional products of cycles of tectonic uplift and Cainozoic volcanism in the SE Highlands of Australia, and correlated periods of non-depositional hiatus in the basin with proposed periods of 'tectonic settling' and diminished erosion in the highlands. Framework tectonics have clearly provided the primary control on development of the basin; however interpretation of the stratigraphy of the basin in terms of the superimposed eustatic influences is believed to provide a more acceptable model to the detail of the model of tectonic cycles.

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APPENDIX

General Statement - Murray Basin Hydrogeological Project

This project is a long-term study which is being undertaken jointly by South Australian, Victorian and New South Wales geological surveys and water authorities and by the Commonwealth Bureau of Mineral Resources, Geology and Geophysics. It will be co-ordinated by a Steering Committee comprising members of those organisations.

The Murray Basin is a geological structure with an areal extent of some 300 000 km^2. In each of the three States the basin sediments contain very large groundwater reserves. Where the groundwater has a low salinity it is increasingly being used for irrigation and town water supply purposes. In much of the basin, the groundwater is suitable only for stock use and is extensively used for this purpose. In other parts of the basin the groundwater is too saline for any use. There is a complex interaction between groundwater and surface water which may be beneficial, as in recharge areas in some parts of the basin, or harmful as in areas of saline groundwater discharge to rivers. In recent years, the States involved have stepped up the rate of assessment of the groundwater regime in the basin.

The primary aim of the Project is to improve the understanding of the groundwater regime of the basin by examining it as a single entity, unencumbered by State boundaries. Since a knowledge of the geology of an area is basic to the understanding of groundwater occurrence, a geological study of the basin is an essential part of the Project and as a consequence it will also be possible to make an assessment of other mineral resources.

The Project is planned initially to last five years and will be organised in five phases:

(1) Geological synthesis, using all available geological and geophysical data.

(2) Hydrogeological assessment, on the basis of available data.

(3) Documentation of deficiencies in geological and hydrogeological information and formulation of proposals for appropriate work programs.

(4) Additional work as approved which could include stratigraphic drilling, aquifer testing, biostratigraphic analysis and isotope hydrology studies.

(5) Development of numerical model(s), if found to be appropriate in the light of the data then available.

Investigation currently being undertaken by State authorities will continue, and data generated by them will be used for the joint Basin Project. Collection, collation and compilation of data during the first phase, and interpretation and documentation of the second and third phases, will be undertaken by officers of BMR with assistance from officers of the State authorities. Additional work required in Phase 4 (e.g. stratigraphic drilling, geophysical investigations) may be conducted by BMR or by appropriate State authorities. The development of a numerical model (Phase 5) if found to be feasible, may be undertaken by BMR. The Project will depend on the close co-operation of staff from all organisations involved, and some movement of staff between organisations for short periods will be necessary. Throughout the study, individuals and organisations will be encouraged to publish results of various aspects of the work. Results of the overall Project will be incorporated into joint publications.