DEPARTMENT OF MINES
SOUTH AUSTRALIA

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LIMESTONE FOR RAILWAY BALLAST

NULLARBOR PLAIN

- Commonwealth Railways -

by

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ABSTRACT

Ballast of moderate quality is won from an indurated fragmental limestone capping on the Nullarbor Plain. The assumption that ballast is available all over the Plain is valid but the thickness of the cap rock zone varies from place to place. There is evidence that the better sites underlie topographic highs.

Recommendations for exploratory drilling and for improving the quality of crusher feed are given.

INTRODUCTION

On the Nullarbor Plain ballast for the transcontinental railway is won from shallow quarries developed adjacent to the track at geographically convenient sites. (Figure 1) The existing quarries were opened without prior exploration on the assumption that sound rock is to be found all over the plain. Good quality rock was won from and is still available in quarry faces at Watson (503 miles from Pt. Pirie) and Loongana (771 mile and to a lesser extent in the quarry at 690 miles near Reid. However, in the currently producing deposit at Cook (569 miles a large proportion of the exposed rock is unsound.

Future ballasting operations will be centered around Reid (688 miles) and the Commonwealth Railways requested a geological survey to assist in developing ballast sources for this work.

Quarries at Watson, Cook , Reid (690 miles) and Loongana were inspected during the period 22.1.68 to 26.1.68 in company with Mr. D. Smith, Maintenance Engineer, Commonwealth Railways.

GEOLOGICAL SETTING

A shallow sedimentary basin, known as the Eucla Basin underlies the Nullarbor Plain. Little detailed geological work has been done in the basin but the regional geological setting is described by Ludbrook (1958). The stratigraphic sequence, passing downwards from youngest to oldest rocks, is summarised below.

Lower Miocene - Nullarbor Limestone - dense crystalline limestone and bryozoal limestone

Upper Eocene - Wilson Bluff Limestone - white chalky bryozoal limestone with flint bands.

Eocene - carbonaceous clays and sands, some coarse sandstone and gravel

Cretaceous - blue shales, carbonaceous shale, sand and gravel

Precambrian basement

Recent drilling adjacent to the transcontinental railway in the South Australian portion of the basin penetrated a similar sequence to that described above. However, in a bore 21 miles south east of Cook, approximately 25 ft. of probable Quaternary limestone was intersected at the surface overlying Nullarbor Limestone (Ludbrook - unpublished report).

As the basin sediments are virtually undisturbed by either folding or faulting, the Nullarbor Limestone outcrops over almost the entire area of the Plain.

The immediate surface is underlain by a band of

recrystallised fragmental limestone, developed in the Nullarbor Limestone. Preliminary palaeontological examination showed the matrix of the fragmental limestone to be younger than the Nullarbor Limestone, suggesting that the cap rock is an indurated post Lower Miocene land surface. The Quaternary limestone referred to above near Cook probably belongs to the same formation

The caprock has an undulating lower surface, (Figure3) the average thickness ranging from approximately 10feet at Cook to over 30 feet at Loongana (Figure 2)

The Nullarbor Plain extends for over 500 miles in an east west direction and, as the name implies, is treeless. Its surface is slightly undulating and there is an overall rise of approximately 250 feet in elevation from Ooldea on the eastern margin to Loongana in the central western section. Usually the undulations are gentle, with an amplitude of 1 to 4 miles, but at such locations as 501 miles (Figure 5), 693.5 miles and 746 miles (from Pt. Pirie) Locally prominent northerly trending escarpments occur.

ECONOMIC GEOLOGY

Quarries at Watson (503 miles), Cook (569 miles), Reid (690 miles) and Loongana (771 miles) and shallow cuttings through the low escarptments provide the only large scale sub-surface exposures on the Nullarbor Plain. Although at each quarry a similar profile is exposed the thickness of the caprock zone varies from site to site.

The cap rock is an off white, hard, recrystallised fragmental limestone which provides a useful but not high quality ballast. The base is usually well defined and is undulating,

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Figure 1 General view of Cook Quarry

W.A 17501

Figure 2 Quarry face at Loongana

B/5 17500

Figure 3 Undulating base of caprock in Cook Quarry

(Figure 2 and 3), the deeper troughs extending for a further 10 to 15 feet below the average base level.

Two other rock types are found in the caprock zone. "Pudding Stone" is a hard rock consisting of angular to rounded fragments of usually black kunkar limestone set in a pale grey or brown matrix. It crushes to a high quality ballast but occurs only in pockets and seams of limited extent which represent former solution holes filled with rock debris and cemented by a calcareous matrix. Large pockets of brown to red brown limy clay often occur instead of the fragmental limestone. These are of significant dimensions and the change from hard limestone to clay is abrupt. (Figure 4) Such zones could be readily identified in drill holes by the colour of cuttings and change in penetration rate of the drill.

Off-white fossiliferous limestone underlies the cap rock. This is usually porous and friable, and is unsuitable for ballast. At Cook a distinctive white oolo-aremite also occupies this zone. At all of the quarries, but particularly at Cook, much of this rock is quarried in the process of extracting the deeper troughs of cap rock and this practice contributes significantly to the large amount of waste which is rejected during crushing. Crusher feed and ballast quality could be improved considerably by reducing the height of the working faces to take only the main layer of cap rock.

Also at Cook, large spalls composed of massive limestone appear to be discarded (Figure 1) This material lies in situ at the base of the caprock zone and might be broken into sizes suitable for crushing by improved loading of shot holes.

There are no obvious surface criteria at any of the quarries to indicate the quality of rock beneath the plain.

c|5 17502

Figure 4 Hard fragmental limestone (left) and red clay (right) in Watson Quarry.

c|5 17503

Figure 5 Escarpment at 501 miles, looking west.

On the longitudinal section on the accompanying plan, Cook (the poorest of the present quarries) lies on level ground on the lowest section of the plain. Watson, in the same area, occupies a local rise and provides higher quality ballast. Reid (690 miles) and Loongana are on relatively flat ground which lies over 200ft. above the level of Cook. There is thus some suggestion that the better sites occupy local topographic highs. On theoretical grounds a cap rock of this type would be expected to have its maximum development in areas which today remain as high ground. However, even in the most favourable locations, some zones of limy clay and porous rock will exist.

At Reid (680 miles) a locally prominent ridge crosses the line just east of the siding and trends northwesterly towards the existing loop line. It is considered that a quarry sited on the ridge has a reasonable chance of exposing a face of good quality rock.

An alternative site occurs on the escarpment located near 693 miles, while elsewhere on the plain potentially suitable sites might exist between 590 and 600 miles, 738 and 746 miles and at 659 miles.

EXPLORATION

Close pattern drilling will be necessary to satisfactorily define a site in advance of quarrying. Because of the rapid changes from hard cap rock to red clay, drilling on a 100 foot grid is desirable. Diamond drilling at this scale would be prohibitive but it is considered that with close technical supervision, a modern blast hole drilling machine could be used satisfactorily.

The boundary between cap rock and underlying limestone could be recognised by examining drill cuttings with a hand lens and the presence of red clay zones in the cap rock would be clearly shown by the colour of cuttings and penetration rate of the bit.

Assuming a thickness of 15 feet of cap rock there are 24,200 cubic yards (in situ) per acre. A volume of 100,000 cubic yards would occupy approximately 5 acres and such an area measures approximately 400feet by 500 feet. Drilling on a grid spacing of 100 feet would require 20 holes to span this area. Allowing an additional 10 holes for soft zones and by drilling holes to 20 feet, a total of 600 feet of drilling would be required to prove 100,000 cubic yards of rock. Alternatively an indication of the quality of rock underlying a site could be gained by drilling 2 or 3 lines of holes across the axis of a rise.

SUMMARY AND CONCLUSIONS

Hard rock suitable for ballast, occurring as an indurated surface caprock in the Nullarbor Limestone, underlies a large area of the Nullarbor Plain. The assumption that rock suitable for ballast could be found all over the Nullarbor is valid.

The depth of the cap rock varies from place to place and the meagre evidence available suggests that the best sites may be found on local topographic highs. Even at these locations some patches of waste rock will be encountered.

At Reid (688 miles) it is considered that a quarry at least as good as that at Watson could be developed on a ridge lying to the north east of the siding.

Close pattern drilling with a modern blast hole type machine could be used to show the presence of sound rock and to define reserves. Such drilling would require close technical supervision to satisfactorily interpret results.

Approximately 30 holes, each to 20 feet, would be required to prove each 100,000 cubic yards of ballast (in situ) the mere presence of hard rock at any site could be shown with lesser amount of drilling.

The quality of crusher feed and ballast could be improved considerably by reducing the height of the working faces to include only the main part of the cap rock zone.

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REFERENCE

LUDBROOK, N.H. (1958) in The Geology of South Australia, Journ. Geol. Soc. Aust. Chapter X

W. A.

S. A.

EUCLA BASIN

Railway

KALGOORLIE 1108

Rawlinna 873

Naretha 903

Loongana 771

Reid 688

Hughes 623

Cook 569

Ooldea 484

Watson 503

Kingoonya 266

Eucla

Nullarbor Plain

PRECAMBRIAN SHIELD

LAKE EVERARD

LAKE GAIRDNER

GREAT AUSTRALIAN BIGHT

GAWLER PLATFORM

PT. AUGUSTA 57

PT. PIRIE 0

SPENCER GULF

ADELAIDE

121° 123° 125° 127° 129° 133° 135° 137° 139°

29° 31° 33° 35°

169

SCALE

MILES 0 100 200 300 400 500 MILES

Mileages from Pt. Pirie ____ 169

Quarry ____ ⚒

STATE BORDER

Naretha 903 900

Rawlinna 873 850

800

Loongana 771 750

700

Reid Quarry 690

Reid Siding 688

Deakin 656 650

Hughes 600

Cook 569 550

Watson 503 500

Ooldea 484

600 400 200 0 FEET

Sea Level

SCALE

MILES 0 40 80 120 160 200 MILES

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