REPORTS FORMING ADDENDA TO THE RECORD OF MINES.

REPORT

BY

The Government Geologist (L. Keith Ward, B.A., B.E.).

NOTES ON

THE STUART'S RANGE OPAL FIELD.

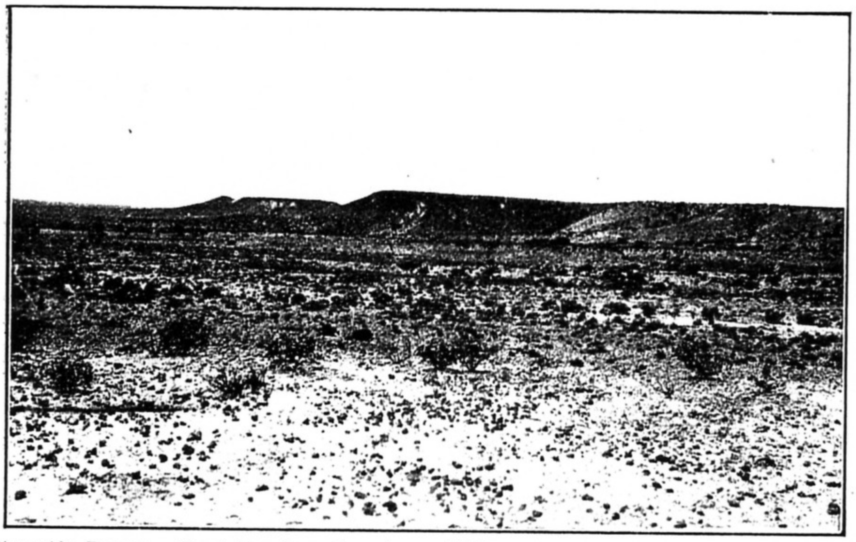
GEOGRAPHICAL POSITION.

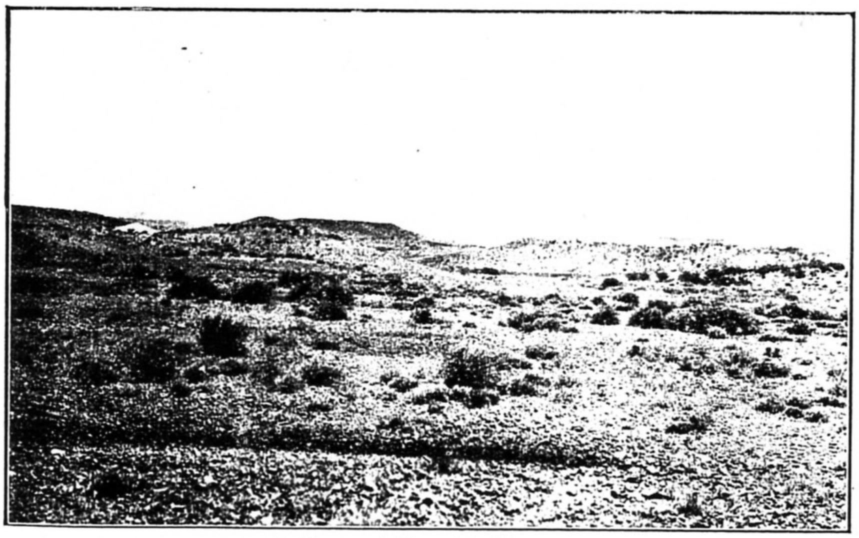
Stuart's Range is the name given to the ridge that constitutes the divide between two systems of surface drainage. The divide extends in a direction having a bearing nearly N.W.-S.E., and separates the basin of Lake Cadibarrawirracanna from that containing Lakes Woorong, Phillipson, and Wirrida. These so-called "lakes" are typical "playas" or "clay-pans" of large size. They contain water only for a short time after heavy rain has fallen, and for the greater part of the year the silt-filled depressions are dry and smooth.

The newly-discovered opal field is situated approximately midway along the range, and its centre may be marked on a map of South Australia at latitude 29° 2′ S. and longitude 134° 48′ E.

The field may be approached from either the Northern or the Transcontinental railway line. The rail journey is shorter by the Transcontinental line, but the distance of the field from Tarcoola is greater than its distance from William Creek Railway Station. Tarcoola is distant 258 miles by rail from Port Augusta, and the distance from this port to William Creek by rail is 356 miles. Port Augusta is 259 miles by rail from Adelaide.

The route followed by the writer to and from the opal field was that which connects with the Transcontinental railway line at Tarcoola. The following table shows the distances between water supplies on this route, and includes notes as to the duration of the supplies in the waterholes. It may be noted that the route may be varied, and thereby shortened, between Tarcoola and Robert's Well, but the facilities for obtaining water on this alternative route are inferior to those on the route indicated in the table (page 3).


Stuart's Range.—Opal-Bearing Country. Gibber strewn soil in the foreground.


A Spur of Stuart's Range.

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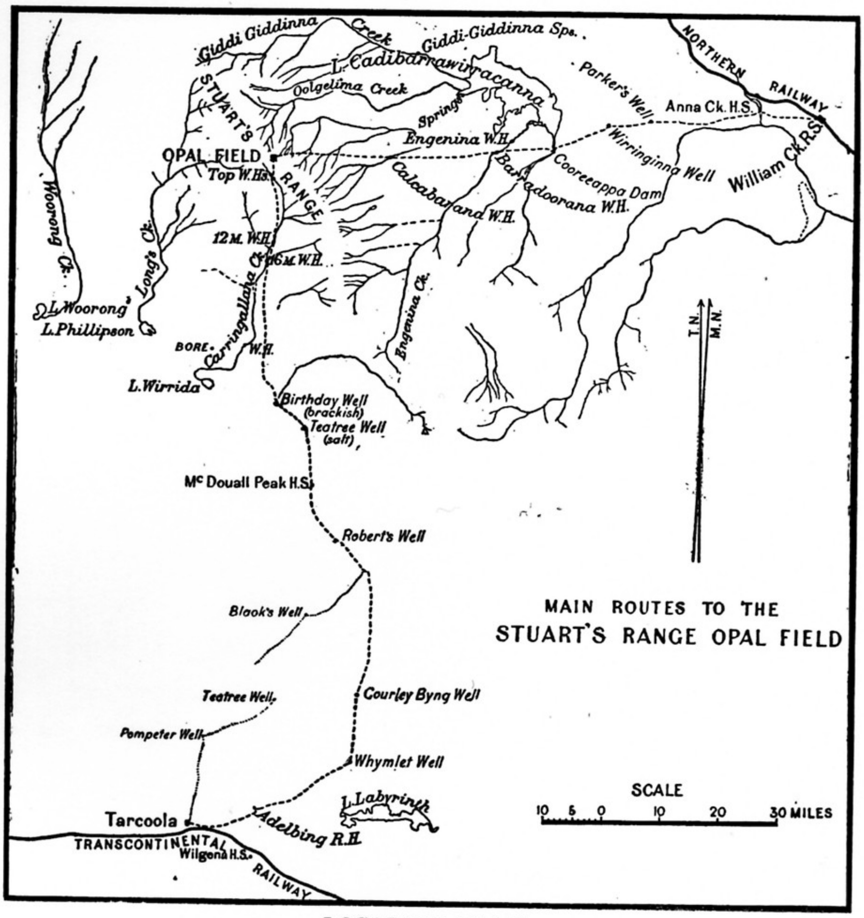


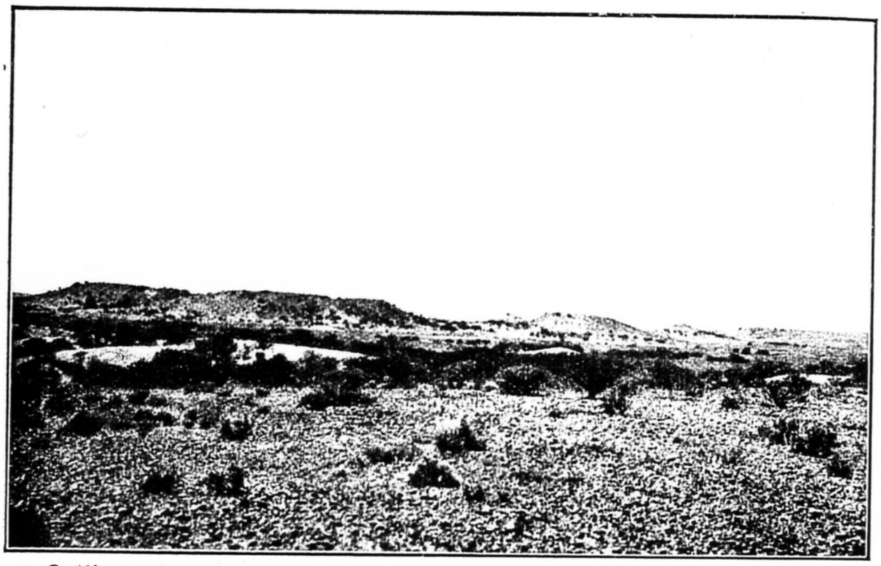
LOCALITY PLAN.

TABLE.

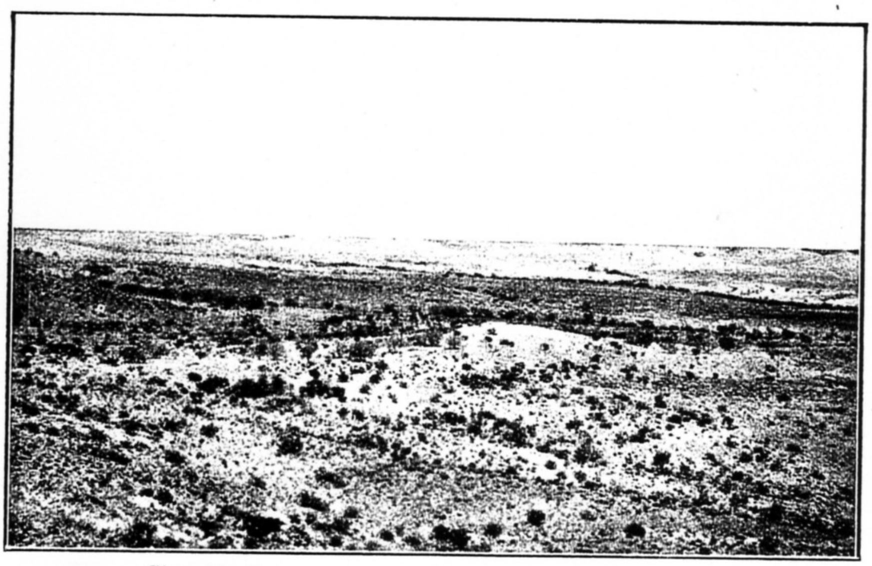
From.	To.	Distance in Miles.	Bearing.	Notes on Water Supplies.
Tarcoola	Adelbing Rockhole .	13½	E. by N.	Large rockhole in granite.
Adelbing Rockhole .	Whymlet Well.....	18¾	E.N.E.	Large supply of good water.
Whymlet Well	Courley Byng Well..	11¾	N.	Moderate supply of good water.
Courley Byng Well..	Robert's Well	28½	N. by W.	Moderate supply of good water.
Robert's Well	McDouall Peak H.S.	11	N.N.W.	Large supply of good water.
McDouall Peak H.S..	Teatree Well	10	N.	Moderate supply of salt water.
Teatree Well	Birthday Well	7	N.W.	Large supply of brackish water.
Birthday Well	16-Mile Waterhole on Carringallana Creek	25	N. by W.	Large waterhole, retaining water for four to five months when filled by rain.
16-Mile Waterhole on Carringallana Creek	12-Mile Waterhole on Carringallana Creek	4	N.N.E.	Large waterhole, retaining water for three months when filled by rain.
12-Mile Waterhole on Carringallana Creek	Top Waterholes on Carringallana Creek	11½	N.	Two holes half a mile apart retaining water for three to four months when filled by rain.
Top Waterholes on Carringallana Creek	Centre of opal field..	3	N.	
TARCOOLA	OPAL FIELD	144	N. by E.	

From information received the following tabular statement has been prepared to show water supplies on the shortest route from the William Creek Railway Station to Stuart's Range:—

From.	To.	Distance in Miles.	Bearing.	Notes on Water Supplies.
William Creek Railway Station	Anna Creek H.S. ..	11	W. by N.	
Anna Creek H.S. ...	Parker's Well.......	20	W. by S.	Good water supply.
Parker's Well	Wirringinna Well ..	7	W. by S.	Supply of fair water.
Wirringinna Well ...	Cooreeappa Dam....	11	W.S.W.	An earthen dam containing fair water after rain.
Cooreeappa Dam ...	Barradoorana Waterhole on Engenina Creek	10¼	W.	Good waterhole, retaining three months' supply after rain. NOTE.—Engenina Waterhole, on the same creek, and 4 miles to the N.E. of Barradoorana Waterhole, contains, when filled, five months' supply.
Barradoorana Waterhole	Calcabarana Waterhole	18½	W.	Large waterhole containing, when filled by rain, six months' supply.
Calcabarana Waterhole	Opal Field	20¼	W.	
WILLIAM CREEK R. S.	OPAL FIELD	98	W. by S.	



Outliers of Stuart's Range Opal-Bearing Country. Gibber strewn soil in the foreground



Stuart's Range, as seen from a Northern Outlier.

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GEOLOGICAL FEATURES.

The central portion of Stuart's Range, where the opal discovery was made, is a remnant of a great tableland composed of almost horizontal beds of sandstone and claystone that were deposited in Upper Cretaceous time. These beds extend beyond the Lower Cretaceous shales that form the impervious cap confining the water of the Great Australian Artesian Basin to the underlying sands. At Stuart's Range the bluish shales of Lower Cretaceous age were not recognised. They may underlie the superficial cover to the northward of the range in the eastern portion of the broad valley through which run Giddi Giddinna and Oolgelima Creeks and their many tributaries. The most westerly springs that may be considered to owe their origin to the escape of the water existing under pressure in the Great Artesian Basin are known as Giddi Giddinna Springs, and are situated on the creek of the same name at the western extremity of Lake Cadibarrawirracanna. These springs, from which water of useful quality is said to be obtainable, are about 30 miles distant from the opal field in a straight line.

The sediments laid down under marine conditions in Upper Cretaceous time have been elevated since the period of deposition and have been greatly affected by erosion. The tableland formed by the elevation of these marine sediments has been dissected by the agents of erosion in a very irregular manner.

The rise northwards to the top of the range from Carringallana Creek is gradual; and, when the crest is reached, the abruptness of the scarp facing the N. is surprising to the traveller. The front of the range is deeply embayed, and many spurs and table-topped outliers remain to show the former northward extension of the plateau. When the front of the range is viewed from one of these outliers the skyline appears perfectly straight. These features are recognisable in the accompanying photographs.

The surface of the tableland is strewn with the mantle of hard siliceous stones or "gibbers" characteristic of the terrain. These siliceous rocks are almost wholly in loose blocks and stones ranging in weight from less than an ounce to a hundredweight or more, but mostly between half a pound and ten pounds. Many have the rounded form of the typical gibber, but many others are angular, and some—composed of impure chalcedony or porcellanite—have jagged outlines. In very few places is there an area of more than a few square feet of solid siliceous rock in this stony pellicle. Where the siliceous crust does tend to become continuous a close examination will in most cases show that a number of gibbers have been cemented together to form a pseudoconglomerate.

The loose gibbers cover the slopes of the northern front of the range and are spread over the valleys and plains extending northwards. The siliceous capping of stones on the outliers of the tableland is gradually removed by erosion, and when the last stage in the life of an outlier is reached, there remains merely a rounded hillock of white or reddish claystone.* Examples of these claystone hillocks may be seen in the accompanying photographs.

Some of the excavations in the claystone show a system of small pipe-like branching veins filled with ferruginous clay.

The place of the claystone is taken by more or less ferruginous sandstone in many excavations at low levels, but so little of the rock beneath the gibber-strewn soil is visible that it is not possible to say whether the claystone invariably overlies a sandstone stratum.

This Upper Cretaceous formation, which is usually known by the name of Desert Sandstone, extends far beyond the limits of the country hitherto proved to be opal-bearing. The map of Australia printed with these notes shows its extent through Queensland, New South Wales, and South Australia. For purposes of reproduction on so small a map the smaller outcrops are necessarily grouped together and many very small outliers have been omitted, but the map has been

* This claystone has not been analysed. It may consist, in part at least, of highly siliceous material in an exceedingly fine state of division. Such is the nature of much of the "kaolin" occurring at White Cliffs, New South Wales.

In the final stages of the weathering of the opal-bearing rock the seams or veins are broken up and fragments are found strewn on the surface. These are gradually bleached by the sun's rays and the surface stone becomes so cracked that it disintegrates rapidly.

A number of veins from which surface stone was shed have been located by the careful investigation of the soil and subsoil at the places where the floaters occur. Some of these veins have been found in place within a few inches of the natural surface, and the quality of the opal is good, in some cases at least, at a depth of no more than 6in.

No general prospecting has yet been carried out. "Color" floaters have been observed at a number of places, and the few prospectors on the field have been occupied in examining the localities where these were discovered, in few instances to a greater depth than 4ft.

The area over which opal has been already discovered has a maximum length, measured in a N.W.-S.E. direction, of about 10 miles, and a maximum width at right angles to that direction of about 2 miles. It is reasonable to expect that this area will be greatly extended when a water supply is assured and it becomes possible for prospectors to work farther afield. Fresh discoveries may be expected, especially to the S.W., W. and N.W. of the area now known to carry opal. The slopes leading down from the top of the dissected tableland offer better prospects of finding opal floaters than the crest where the mantle of gibbers is densest.

The amount of work hitherto carried out is not sufficient to indicate any particular rock type at Stuart's Range as being specially favorable to the formation of opal veins. In some excavations the opal occurs in sandstone, and in others it is found in claystone. One peculiar association was noted at a small opening in the central part of the field. The excavation disclosed a vein of opal in a fine-textured white mineral which breaks with a flat conchoidal fracture. A sample of this mineral was analysed by Mr. W. S. Chapman, Departmental Analyst, with the following results :—

	Per cent.
Silica	1·04
Alumina	35·44
Ferric oxide	2·06
Magnesia	·04
Lime	·42
Soda	4·88
Potash	5·26
Water at 100° C.	·78
Water over 100° C.	11·71
Phosphoric anhydride	trace
Sulphur trioxide	38·50
Chlorine	·51
	100·64
Less O, equivalent to Cl	·12
	100·52

This analysis shows that the mineral is a variety of the alunite species in which the potash has been partly replaced by soda.

The association of opal with alunite has been recorded by E. S. Larsen in the San Cristobal Quadrangle, Colorado, U.S.A.*

When the mode of occurrence of precious opal in the Desert Sandstone of Australia is viewed in conjunction with its characteristic geographical distribution, the hypothesis that the opal owes its origin to the reaction of arid climatic conditions

* E. S. Larsen, Bull. 530, U.S. Geol. Survey, pp. 179-183.

on a particular series of rocks suggests itself. Opal, like alunite, may be deposited from hot springs, but neither mineral* is exclusively formed by hot solutions ascending from considerable depths.

The Desert Sandstone series carrying the precious opal in Queensland, New South Wales, and South Australia includes similar rock types in all three States. Superficial silicification is characteristic of the series and is not restricted merely to isolated places. It is brought about by the redistribution of part of the silica in the rocks constituting the series, and in this re-arrangement of material climatic influences probably play an important part.†

The region in which, with one exception, the precious opal fields of Australia (all of them being comprised within the Desert Sandstone series) lie has a rainfall of less than 15in. per annum. The Lightning Ridge field, at Wallangulla, New South Wales, lies but just outside this region, and has a rainfall of about 16½in. per annum. The 15in. isohyetal line will be seen from the map on the next page to approach the eastern opal fields of Queensland very closely, and to swing round to the W. at a point near the most northerly field (Kynuna).

It therefore seems possible that the development of opal (hydrous silica) is a special phase of the silicification of the upper portion of the Desert Sandstone that is more prominently shown by the jasperoid or porcellanite capping, and which is largely due to the arid climate of Central Australia.

THE METHOD OF WORKING THE OPAL DEPOSITS.

The method of working is extremely simple. At a spot selected, more or less at random, but generally close to a place where "color floaters" have been obtained, the prospector works over the soil with a pocket knife. The proximity of a vein is indicated by the presence of more or less bleached opal in the soil, and these indications are followed till the vein itself is located. The vein is followed with great care, and the opal is taken from the matrix with a pocket knife. Such trimming as may be necessary is effected with a pair of pliers.

The prospector's tools are few and inexpensive, the whole outfit consisting of pick, shovel, knife, and pliers. As deeper and more extensive work is undertaken a windlass and wheelbarrow may be needed.

GENERAL CONDITIONS ON THE OPAL FIELD.

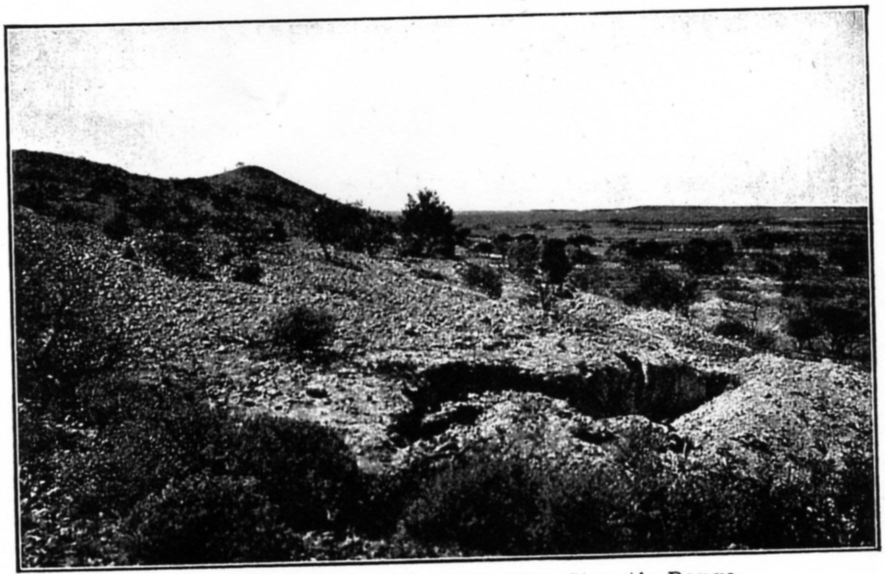
Since the discovery of the field, in the early part of 1915, work has been intermittent on account of the difficulty of obtaining enough water for the use of the prospectors and their transport animals. The writer's visit to the field in October, 1916, was made immediately after good rains had fallen, and the waterholes near Stuart's Range were full. The field was at that time temporarily deserted, but men are now returning there to work.

Those prospectors who have visited the opal field have been equipped with the means of carrying stores and water. This independence has hitherto been essential, since there is no provision store on the field and the means of carrying water from the waterholes to the camps must be possessed by anyone wishing to work there. A large storage tank at the camp and a small tank of, say, 100galls. capacity, or camel canteens or drums to convey the water in a cart or on camel back from the waterholes to the storage tank are required. Much of this now unavoidable expense and labor will be dispensed with if the scheme of well-sinking now being carried out by the Government proves successful. A store will probably be opened on the field as soon as a permanent water supply is obtained.

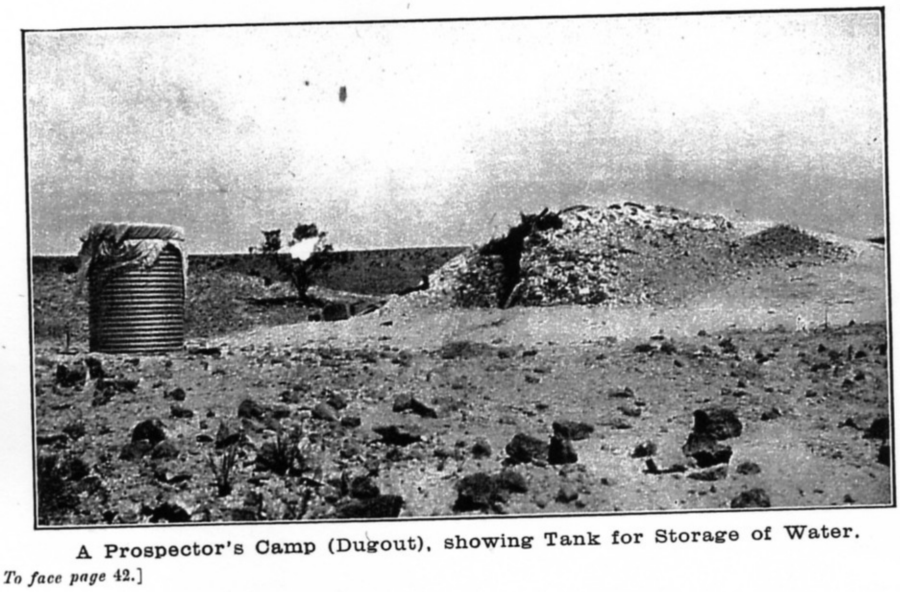
At the present time the field carries a sufficiency of feed for horses or camels. Little fresh game is obtainable, rabbits being scarce, and few wild fowl being attracted to the waterholes.

* *Re* origin of alunite, see F. L. Ransome, Economic Geology, vol. II., No. 7, p. 668.

† Compare observations on the superficial silicification of lodes and fracture zones in Northern South Australia, Geol. Survey South Australia, Report No. 3, p. 9.



Eastern Workings at One Tree Hill, Stuart's Range.



A Prospector's Camp (Dugout), showing Tank for Storage of Water.

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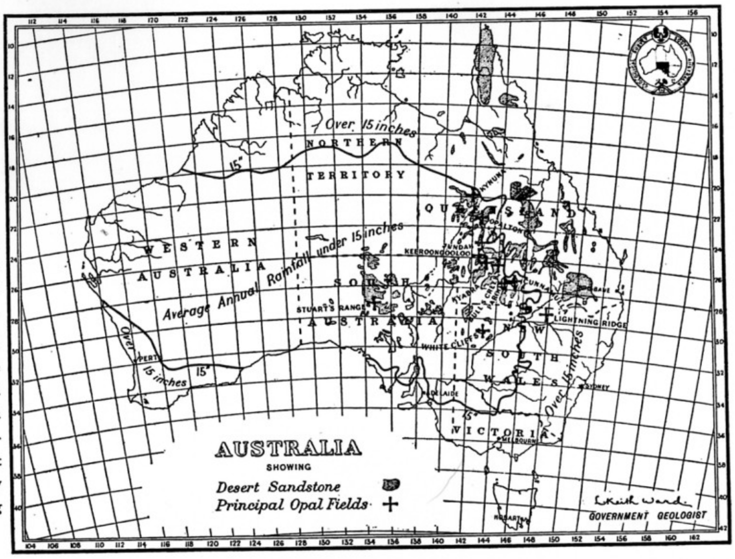
THE PRINCIPAL OPAL FIELDS OF AUSTRALIA.

This map shows the position of the principal Australian opal fields in which precious opal is won from the Desert Sandstone series of Upper Cretaceous age.

The area which receives an average annual rainfall of less than 15 inches is also indicated.

The shaded areas show the present extent of the Desert Sandstone, which was once continuous over a very large area in Central and North-Eastern Australia.

That the opal deposits indicated on this map may possibly be due to the reaction of arid climatic conditions on the Desert Sandstone formation has been suggested as a hypothesis. On this hypothesis all the developments of the Desert Sandstone in South Australia are worthy of the attention of prospectors searching for precious opal.



Opal-mining is a branch of the mining industry for which a large amount of capital is unnecessary and which is unsuited for the operations of a company. The nature of the occupation, the mode of occurrence of the opal, the methods of working, and the simple equipment necessary combine to make opal-mining an industry that flourishes only when the individual prospector owns and works his own ground. Experience gained in New South Wales has given clear proof that any attempt that may be made by a company to work opal-bearing ground of this character is not likely to prove successful.* The conditions existing on the Stuart's Range field are in all respects similar to those under which opal is mined at White Cliffs, and the policy of development that has proved successful in New South Wales is likely to prove equally effective in South Australia.

The State is endeavoring to render aid to opal miners by taking measures to make it possible for prospectors to remain on the field through the dry seasons, and to move to and from the field by a route that is provided with wells at intervals permitting the journey to be made by easy stages.

CONCLUSION.

The discovery of precious opal at Stuart's Range is probably the most important mineral discovery that has been made in South Australia for many years. The prospects of the field seem bright, and the present shortage of water will undoubtedly be remedied. The local supplies of water must be materially increased before the field can prove attractive to many prospectors, and an effort is now being made to augment existing supplies and to render permanent occupation possible. This effort being successful, the field will probably draw many prospectors. The pursuit of opal mining, though somewhat speculative in its nature, is nevertheless alluring to the man who is content to work under the conditions existing throughout the central portion of this continent. There is ample justification for any opal miner going to Stuart's Range to look forward to the discovery of valuable opal. But the prospector who does decide to go to Stuart's Range at the present time must bear in mind that there is other work than that of prospecting before him, and that he must be properly equipped for this work which is concerned with the transport of stores and water.

* The many aspects of this question are fully set forth in the "Report of the Royal Commission appointed to inquire into the Opal-Mining Industry at White Cliffs," 1901.