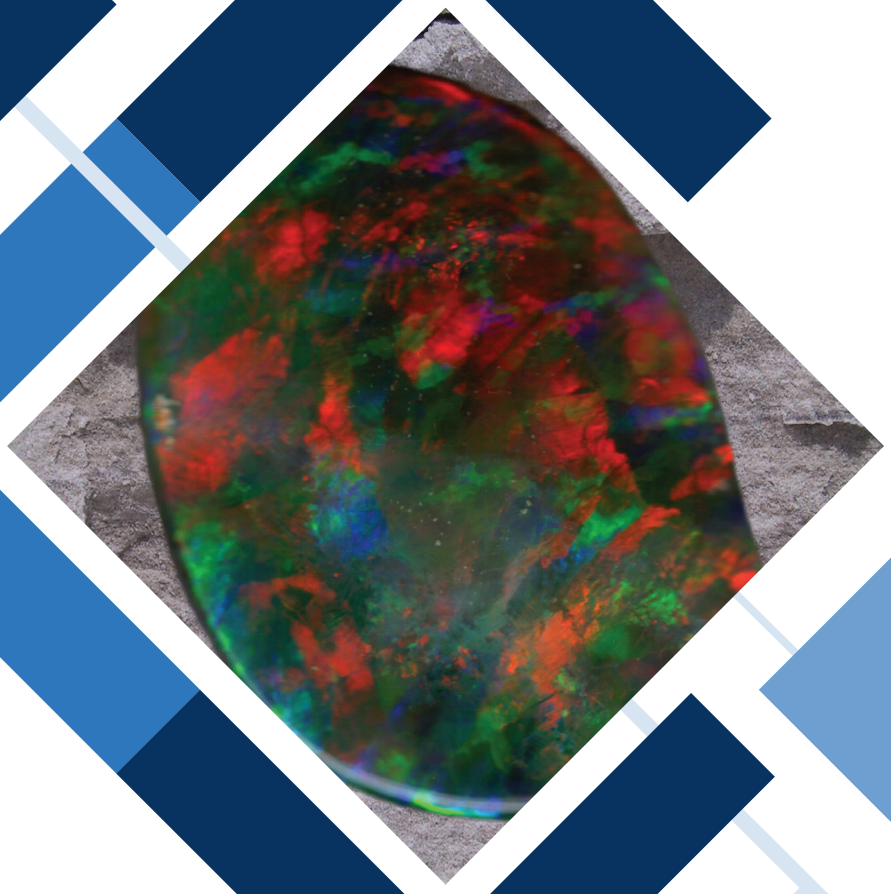
Mintabie opal resource evaluation: Current value of opal resources and projected value of undiscovered resources



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SOUTH AUSTRALIA

Government of South Australia
Department for Energy and Mining

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**Geological Survey of South Australia,
Department for Energy and Mining**

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Cover photo
Black Opal from the Old Field diggings at Mintabie, 1989. (Photo 416712)

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Mintabie opal resource evaluation: Current value of opal resources and projected value of undiscovered resources

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ABSTRACT

A detailed spatial analysis shows that after approximately 40 years of mining in Mintabie, an area totalling less than two square kilometres has been intensively mined. A conservative estimate of the area of greatest prospectivity within the Mintabie Precious Stones Field is 20 square kilometres. Within the 20 km^2 region of high prospectivity, the Mintabie opal field will support Mining for 400 years at the levels already experienced in its lifetime to date. Complimentary analysis performed in 2002 reveals further prospective regions within the Mintabie PSF totalling 44 km^2. The total value of the opal mined at Mintabie to 2016 has been estimated by the South Australian Government to be $412M. An area-based analysis concludes that this is less than 10% of the total contained opal at Mintabie. The opal resource in Mintabie, including the opal already found is therefore estimated to have a raw opal value of over $4B.

SCOPE, CONTEXT AND METHODOLOGY

The aim of this review is to provide an informed view with a level of precision suitable for understanding the tenor of remaining opal resources at Mintabie. The natural distribution of opal within their host formations is very irregular (i.e. extreme nugget effect) and therefore renders the application of conventional (predictive) resource assessment methodologies inappropriate. Accordingly, an empirical approach has been applied in this review which recognises the production history of the field to date (inclusive of mining methods and production output) and the author's extensive personal history as an opal miner at the Mintabie field (15 years) with over 30 years' experience in opal processing and manufacture at wholesale and retail levels, together with the author's experience as a geoscientist, specifically in the area of resource potential mapping using GIS. This assessment also benefits from the availability of present day remotely sensed data that previous considerations have not benefitted from. References to the dollar value of opal production are based upon statutory publications. Previous technical publications by the Department of Mines, South Australia are also considered in this evaluation.

INTRODUCTION

Opal at Mintabie (Fig. 1) is said to have been discovered in the early 1920s, with the first official record reported in 1929 by the Queensland Government Mining Journal (Barnes et.al., 1992). In 1931, The Mining Review (Adelaide) stated "A new occurrence of opal has been found at a place 15 miles southwest of Mount Johns… similar to, but of a darker shade than that found at Coober Pedy" (Barnes et.al., 1992). This darker shade of opal has become globally recognised as Mintabie semi-black opal. Mintabie also produces fine quality crystal, light and black opal, all of which have become highly regarded globally for fine quality and internal stability. In 1992, Barnes indicated that from 1985–89 Mintabie was the largest producer of opal in Australia in terms of value, even though a greater volume of opal was produced by Coober Pedy. This statement underlines what is well known throughout the wider opal community – that opal produced at Mintabie stands among some of the finest quality opal in the world.

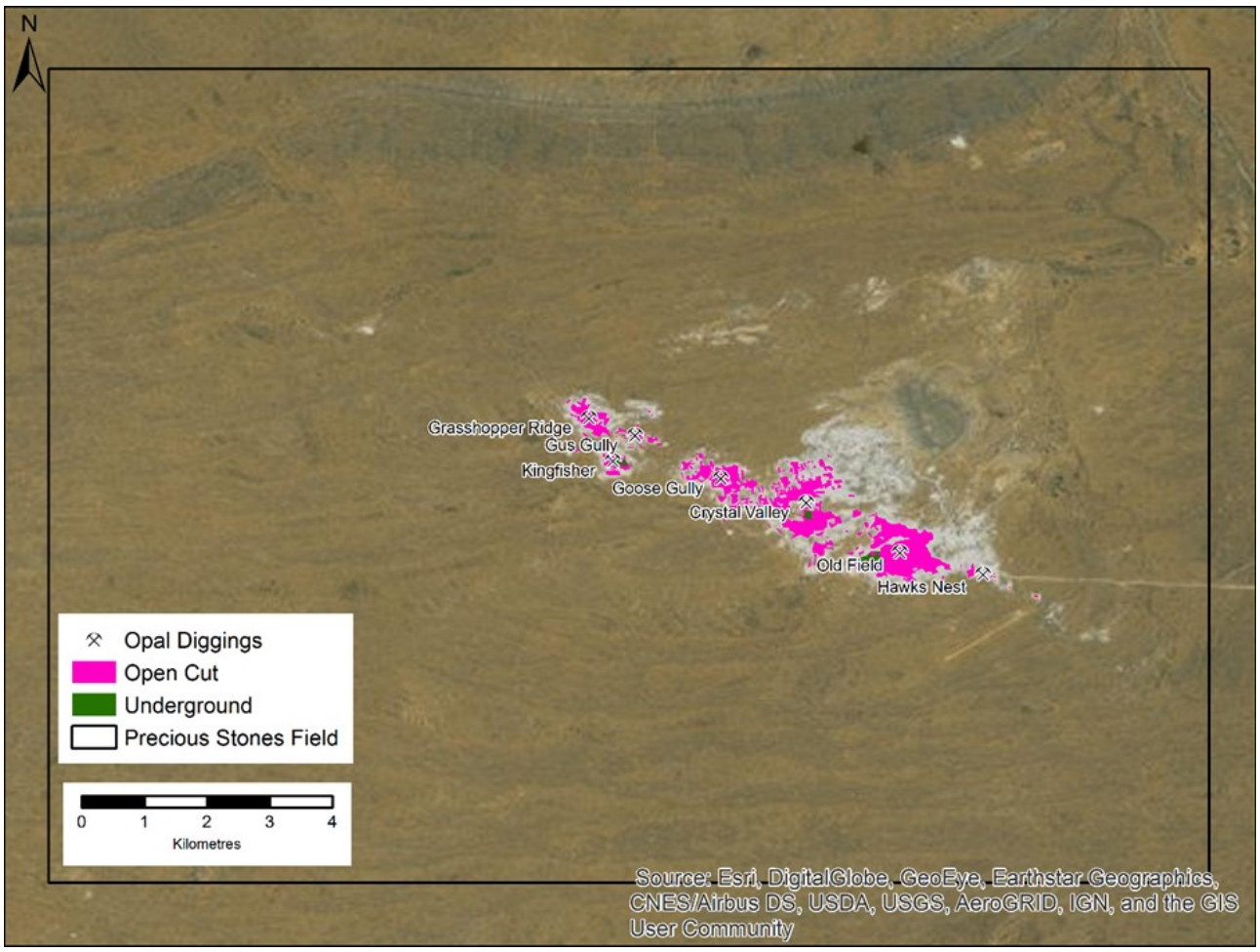

Figure 1. The Mintabie Precious Stones Field. The magenta areas are those that have had intensive mining activity.

GEOLOGY

Townsend (1990) provides an in-depth description of the geology of the Mintabie Precious stones field. The geology of the Mintabie precious stones field differs from all of the other major opal producers in South Australia, being the only field that produces opal within Palaeozoic rocks. The host rock for the opal at Mintabie are the Mintabie beds which comprise well sorted, white kaolinitc sandstone with minor claystone interbeds, thought to be important in the opal formation, as they are interpreted to be acquicludes. The Mintabie opal field developed around the Mintabie beds, which crop out extensively along the Mintabie escarpment and dip gently to the south west. The beds are overlain by a thin veneer of Cretaceous sandy shale, silicified Tertiary sandstone and Recent sand dunes. The upper sediments are often found to be silicified, forming a massive silcrete capping which is present in many areas. This capping, known locally as “cap-rock” requires blasting to penetrate in most areas. The main structural controls for opal formation at Mintabie are vertical joints in the sandstone that strike in a north-westerly direction, crossed by less-frequent vertical joints striking south-west. The joints themselves may carry opal intermittently and connect with horizontal silicified bands in the sandstone that produce opal in horizontal and sub-horizontal seams known locally as “pockets”. These silicified bands define the opal bearing levels, but are not regularly distributed throughout the field either laterally or vertically, making it difficult for miners to consistently find opal using underground mining methods.

A BRIEF HISTORY OF MINING IN MINTABIE

After the discovery of opal along the Mintabie escarpment in 1931, arduous living conditions (Hiern, 1965), the presence of quartz-rich sandstone as a host rock and the silcrete capping deterred mining for decades. It was not until the introduction of heavy machinery in the mid-1970s that the field came into large scale opal production. Since that time, open cut operations have been the preferred method of mining for opal in Mintabie, although there were some underground mining operations in the field. Early mining equipment was not capable of efficiently mining open cuts to great depths and additionally, with the 50 x 50 m limit on precious stones claim size during the 1970s and most of the 1980s, managing overburden from open cut mining operations limited the depth of exploration. For these reasons, the depth of open cut mines during the period from mid 1970s to early 1980s was limited to around 10 to 15 m. At these depths, miners often located a greenish coloured clay band and the belief at that time was that the ground became unproductive below this level, so mining would stop once the “green ground” was reached. From the 1970s to the early 1980s almost all of the opal mining took place in the “Old Field”.

During the 1980s there was a surge in opal mining in Mintabie after the expansion of the old field in a north westerly direction along the escarpment which resulted in the discovery of the Crystal Valley and Goose Gully diggings. A large influx of mining families soon followed which saw the population increase to over 1000. Several additional new diggings along the Mintabie escarpment were then discovered: Gus Gully, Kingfisher, Hawk’s Nest and Grasshopper Ridge. This period also brought new and larger machinery, including scrapers and excavators capable of mining to greater depths. The introduction of the Large Claim (up to 100 m x 50 m) and scrapers meant overburden from open cut operations could be managed more effectively and overburden could be deposited some distance from the open cut mines. Opal claims in the Old Field began to be re-worked to depths from 15 to over 30 m and many large discoveries were made, including discoveries below the green clay bands. This period also saw the introduction of skid-steer loaders which made underground mining easier, as the opal bearing levels could be accessed from the wall of a disused bulldozer cut.

From the mid-1990s to the present day, mining methods further evolved to utilise excavators and dump trucks which cut operating costs, although the time taken to work claims increased using this method. A combination of these methods and traditional open cut mining are still in use today in various parts of the opal field.

CURRENT ACTIVITY

A GIS analysis of the Mintabie Precious Stones Field using recently acquired satellite imagery identified the following equipment operating in the field: 6 bulldozers, 2 dump trucks, 2 excavators, 2 front-end loaders and 1 noodling plant. With the exception of 2 bulldozers, all of the equipment was located in the Old Field (Fig. 2). As a random sampling of activity in recent time (the imagery is assumed to be less than one year old), it is an encouraging sign of mining activity at Mintabie.

A conversation with an opal miner in Mintabie (November 2017) revealed that all of the miners currently operating in Mintabie are finding precious opal, although the amount of opal produced is not known.

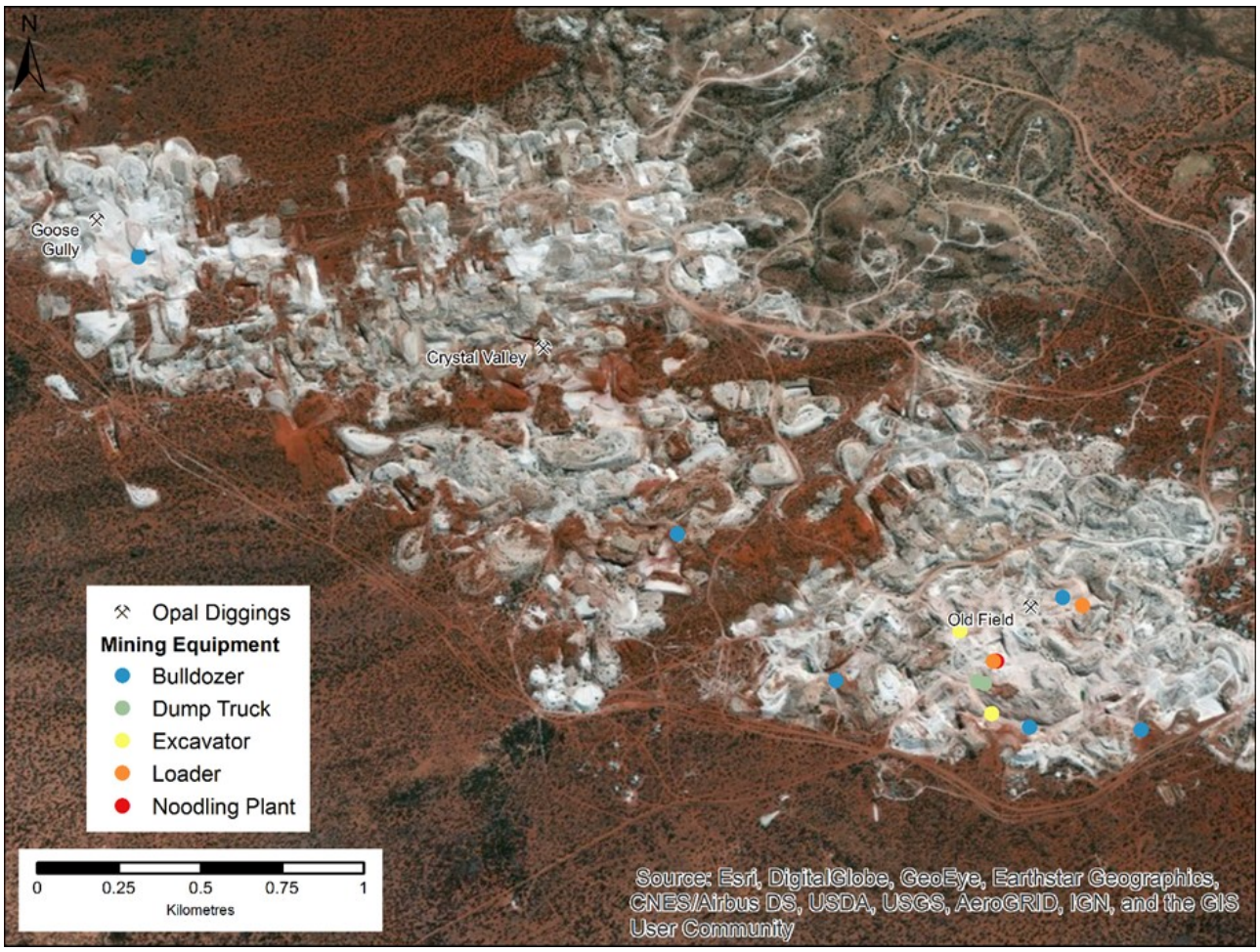

Figure 2. Mining equipment present on the Mintabie Field in 2017. Most of the operations are currently taking place in the Old Field.

ANALYSIS OF CURRENT DIGGINGS

The logistics of open cut mining using bulldozers dictate that there must be a rear access ramp with a gradient of approximately 30° for the bulldozer to access the open cut and a mullock heap ramp with a gradient of approximately 20° to push the overburden out of the cut. The impact of these logistics is that for a given bulldozer cut, at least 50% of the opal bearing level is hidden beneath the ramps. In ideal circumstances, an operator can progressively work a line behind the rear ramp, taking all of the ground in the ramp and filling the cut in front, but when there are many operators in the area at the same time competing for working space, this can become unfeasible and as a consequence virgin ground is left behind or buried. Local miners are currently in the process of reworking the existing fields in preference to seeking out new fields.

Areas affected by intensive open cut mining and adjacent underground mined areas have been digitised (Fig. 3), leaving out areas that have not yet been mined, or are covered by mullock heaps or scraper dumps, the latter having a high probability of fresh sandstone underneath. The areas of intensive activity all lie southwest of the Mintabie escarpment, the base of which is shown in Figure 3 as a red line, digitised from the contoured Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM), approximating the 378 m elevation contour.

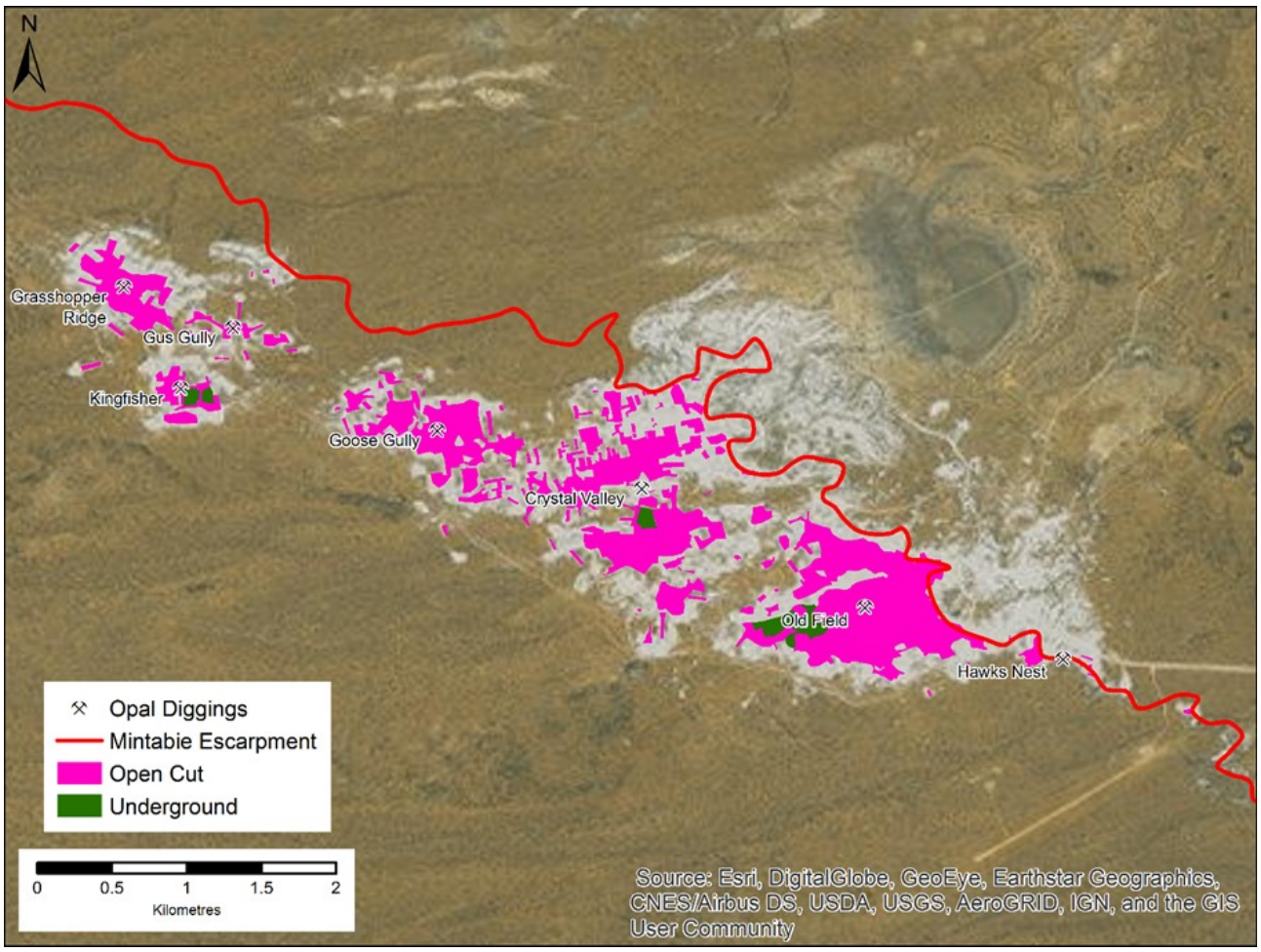

Figure 3. Actual diggings (as opposed to areas covered by overburden or weathered surface material) have been digitised to calculate the area of intensive mining activity at Mintabie. The Mintabie airstrip is visible in the south-eastern corner of the image.

PREVIOUS DEPARTMENTAL REPORT

Between the years 2000 and 2002, the Mintabie opal drilling program drilled exploration drillholes to the northwest and southwest of the current workings. A report on the program by Gum (2002) delineated tracts prospective for opal based on drilling results. The drilling program located prospective sandstone and recovered common opal from a number of holes some distance from present workings, confirming the potential of the drilled areas to host opal. Figure 4 displays the drilling results and prospective zones. The tract adjacent to the Mintabie escarpment that encompasses and expands the current diggings to the northwest and southwest is 31.5 km^2 in area. The region to the southeast of the current workings was not drilled, most likely due to the presence of the Mintabie Airstrip. A second tract, approximately 5 km southwest and running parallel to the escarpment is 27.3 km^2 in area.

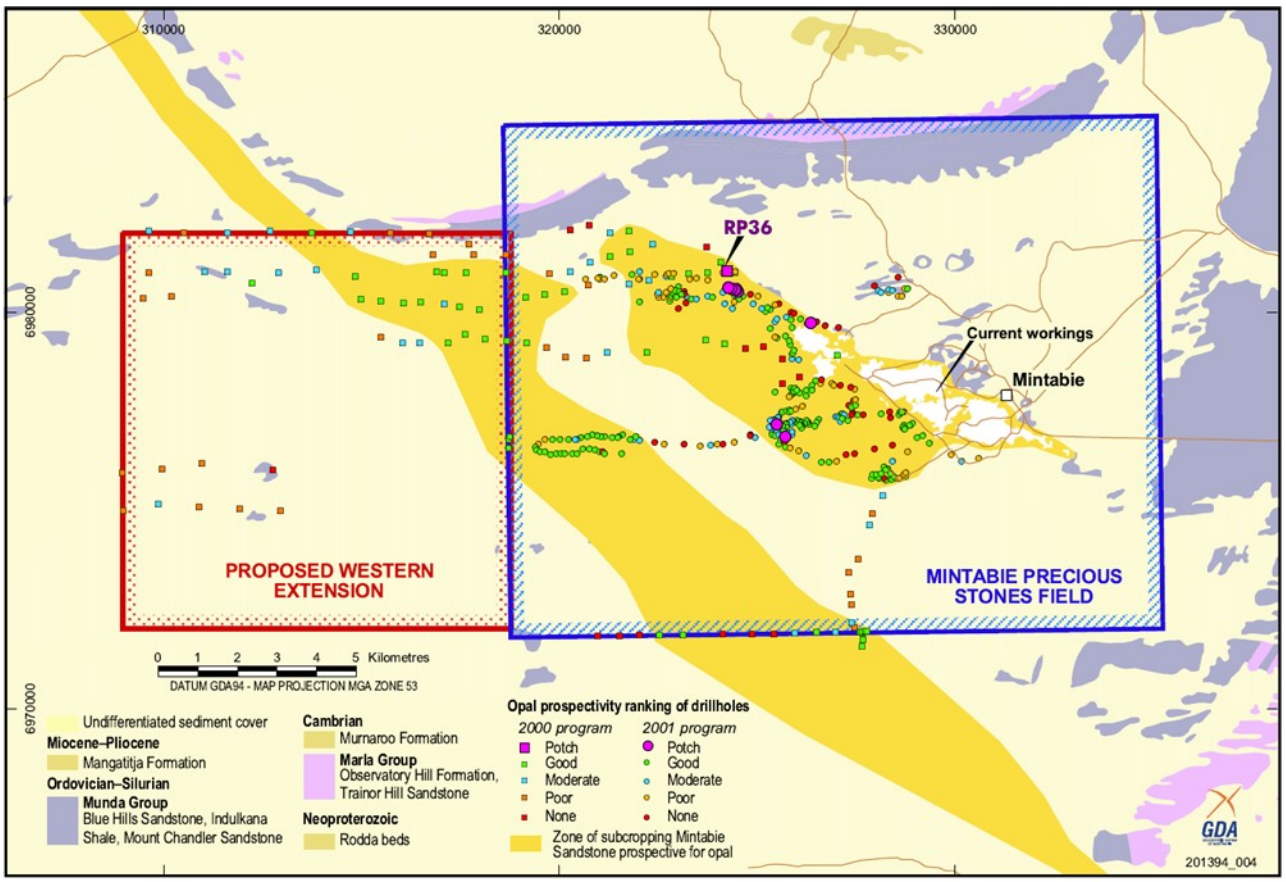

Figure 4. Drilling results that helped define areas permissive for further production of opal at Mintabie, based on the presence of Mintabie Sandstone (image from Gum, 2002).

POTENTIAL FOR FURTHER OPAL PRODUCTION

The Mintabie Escarpment is delineated by the SRTM digital elevation model (Fig. 5). The escarpment runs for about 12 km in a northwesterly direction. The opal bearing Mintabie beds outcrop at and near the face of the escarpment over much of its length. Opal producing sandstone has been found in a line parallel with the escarpment, on the up-thrown side, currently mined over a distance of approximately 1 to 1.5 km from the face of the escarpment over a distance of about 6 km along-strike.

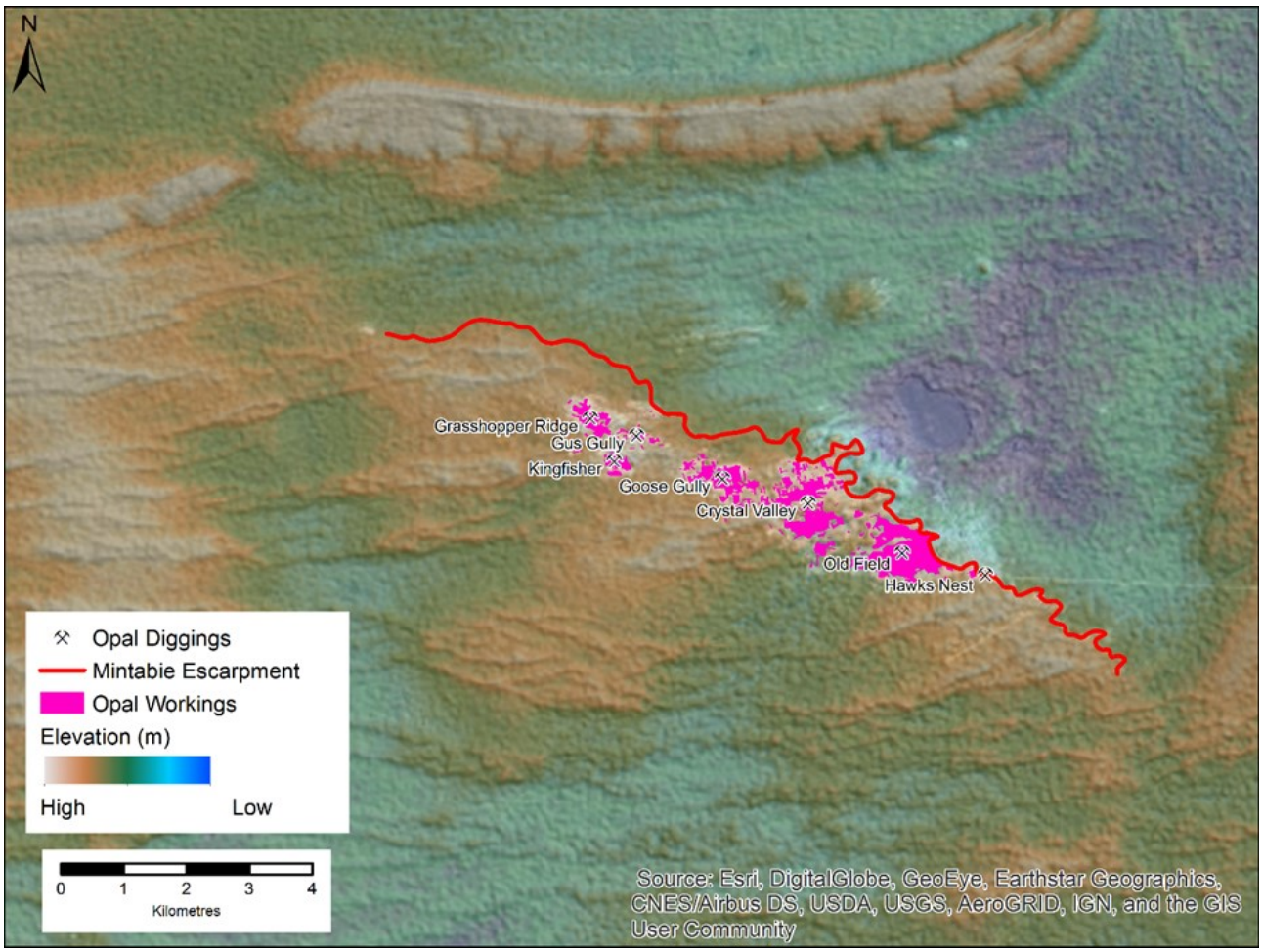

Figure 5. The Mintabie Escarpment as shown in the SRTM DEM. The opal fields are situated on the southwest side of the escarpment on the up-thrown side.

The potential for further sustained opal production from the Mintabie Opal Field is very high. The GIS analysis of the current workings using recent satellite images reveals significant areas within the known fields are still under-explored and un-worked. The only impediment to further mining of the areas between the existing fields is the increased thickness of the sand covering the opal bearing sandstone (up to 10 m of sand, where sand hills intersect the field in an east-west direction). Moreover, the deeper opal bearing levels in the existing mined areas (particularly the Old Field) are highly prospective and are currently being re-worked by miners who understand that there are numerous ramps with unmined opal bearing levels and previous work that left un-worked sandstone at mine-able depth. Re-working this ground has been made possible in part due to the lower number of precious stones claims in the area, allowing miners to better manage overburden to reveal and mine the deeper levels. Figure 6 shows a bulldozer at work in a large open cut mine in the Old Field. This mine is a clear example of re-worked ground.

Figure 6. A bulldozer works a large area in the heart of the Old Field, indicating significant unmined areas within previously worked ground.

Given the current diggings occupy about half of the strike length of the escarpment, as interpreted using the DEM image shown in Figure 5, it is highly plausible that the un-mined sections along the Mintabie escarpment are highly prospective and the prospective region broadly coincides with the elevation of the up-thrown section of the escarpment shown in Figure 5. Figure 7 displays the region deemed to be the most prospective, as guided by the DEM and location of the known diggings along the escarpment, with further prospective regions delineated by the drilling programs performed in 2000 and 2002 (Gum, 2002). The most prospective region concurs broadly with the findings of the report by Gum (2002) with the key difference being the inclusion of the area in the southeast that overlies the Mintabie Airstrip. The most prospective region measures 20.8 km^2 in area. The remaining prospective regions delineated by the 2000 and 2002 drilling programs (not including the most prospective region) cover an additional 44.3 km^2.

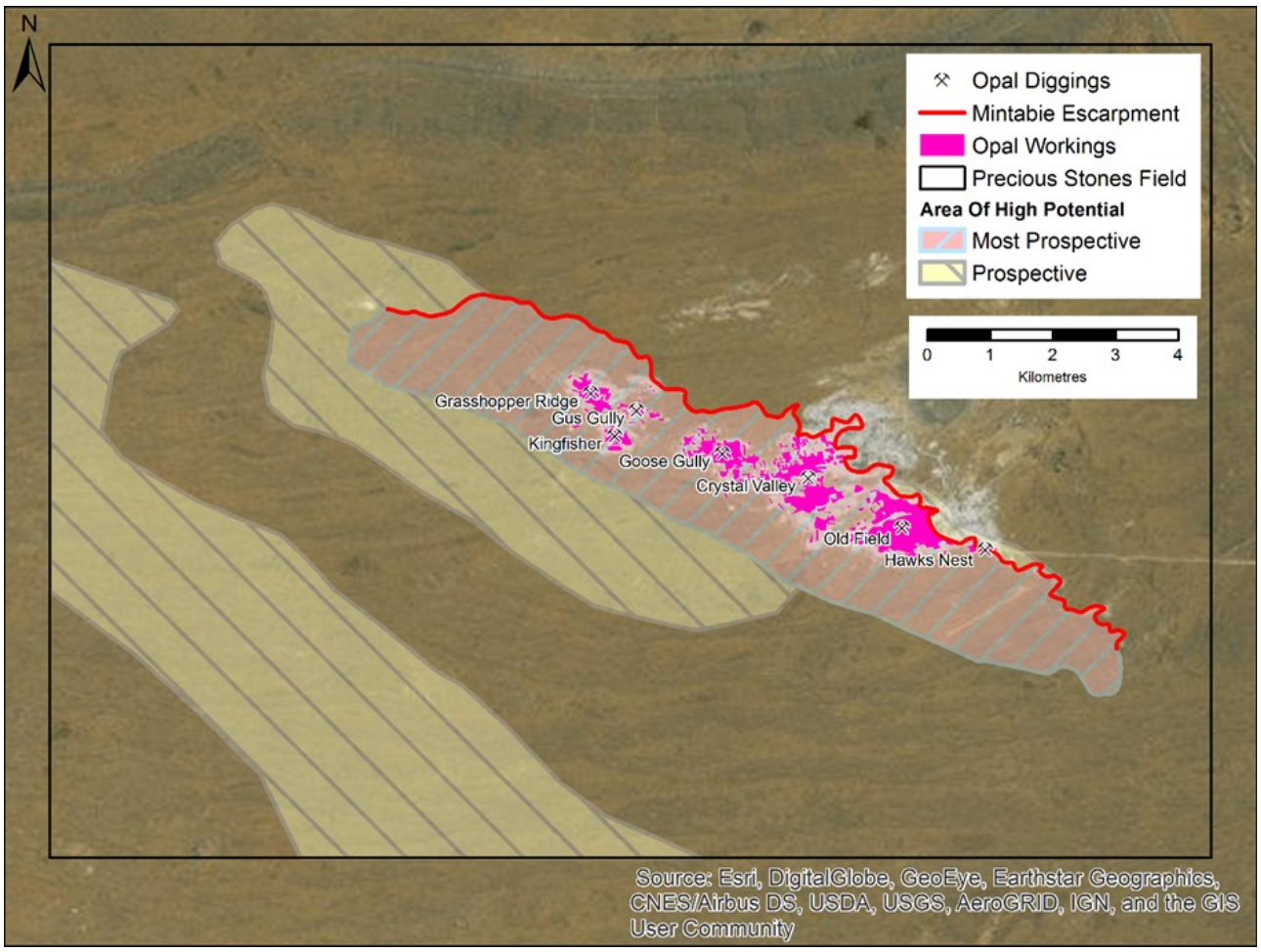

Figure 7. The Mintabie Escarpment as defined by the SRTM DEM guides the interpretation of the most prospective area within the Mintabie Precious Stones Field.

Table 1 considers the area that has been mined intensively, shown in magenta in Figure 7. The intensively worked regions total 1.9 km^2. Of the 213 square kilometres of the Mintabie Opal Field, the area considered to be the most prospective is that area along strike of the escarpment for a width of about 2 km, producing a region with an area of 20.79 km^2. Subtracting the worked regions leaves a highly prospective opal bearing region 18.9 km^2 in area. Since 40 years of mining operations have worked through only 1.9 km^2, the remaining most prospective area will require at least 400 years to exhaust the resource, if worked at the same rate as the first 40 years.

Table 1. Evaluation of intensively worked area as a proportion of the total prospective region at Mintabie.

Region	Area
Area of intensive workings	1.9 km^2
Most prospective area	20.8 km^2
Remaining area (high potential minus worked areas)	18.9 km^2
Percentage of most prospective area worked	**9%**
Other prospective areas (Gum, 2002)	44.35 km^2

It is expected that the areas within and immediately surrounding the current diggings will be the focus of mining activity in the immediate future. Only after these areas are perceived to be exhausted will effort extend to those areas laterally adjacent to the current workings, unless drilling results in significant new discoveries.

VALUE OF THE RESOURCE

Information collected by the department since 1978 using methods described by Crettenden et.al. (1980) estimates the value of raw opal produced from Mintabie from 1978–2016 to be $412M in raw opal product (Table 2). This amount of raw opal has a wholesale processed value of approximately $825M, which in turn translates to a potential retail value of $2477M. These estimates use both conservative and plausible market values within opal wholesale and retail sectors.

The analysis of the undiscovered Mintabie resource estimates a value of around $3.6B in raw product. This estimate takes into account the production figure estimates of the opal mined to date ($412M) with the area mined to date (1.9 km^2) and superimposes those production figure estimates over the 18.9 km^2 un-mined high potential region immediately adjacent to and along strike of the existing diggings.

Table 2 shows that annual production of opal in Mintabie peaked in the five years from 1987–1991 before declining in subsequent decades, a trend that continues to the present time. Compared with the other major South Australian opal fields, a similar trend is observed at Coober Pedy, while production in Andamooka appears to have peaked from the mid-1990s through the early 2000s, most likely due to the influx of workers from Olympic Dam, who took up residence at Andamooka and mined for opal as a hobby.

Table 2. Annual opal production from Mintabie Opal field. Source: Mintabie Review 2017 (internal departmental document).

Years of opal production	Production ($M)		
	Mintabie	*Coober Pedy*	*Andamooka*
1978–1981	27.28	123.57	14.39
1982–1986	51.85	88.84	14.85
1987–1991	141.12	96.34	17.86
1992–1996	82.6	91.9	21
1997–2001	61.93	83.5	19.84
2002–2006	24.56	81.05	20.78
2007–2011	13.08	48.76	11.79
2012–2016	10.48	46.74	12.39
Total production	**412.9**	**660.7**	**132.9**

CONCLUSIONS AND RECOMMENDATIONS

Opal is Australia's national gemstone, with more than 95% of world opal production coming from South Australia, New South Wales and Queensland. Although South Australia's opal production continues to be significant in quantity, opal production in South Australia is in a steady decline. Decreasing opal production from South Australian opal fields cannot be entirely attributed to scarcity of opal but should also consider rising costs of fuel and explosives, rising living expenses, land access constraints and a shortage of new miners entering the industry.

To reinvigorate opal production at Mintabie, historical air photos could be used to capture and reconstruct the history of open cut opal mining, making it possible to build a time series of open cut operations, thereby permitting the identification of shallow workings or un-worked, viable areas beneath mullock heaps. Opal drilling programs such as those run in 2001 and 2002 should be considered to provide baseline geological context and provide preliminary prospectivity testing of the areas interpreted as being prospective in this report.

To better assist opal exploration both within Mintabie and throughout South Australia, scientific methods that make opal targeting possible need to be thoroughly tested. The use of electrical techniques (galvanic resistivity), (Zhe and Morris, 2006) together with modern high-resolution imagery, mapped regolith and elevation data has potential to aid in delineating lithological and structural information at a scale that can be readily tested with prospecting drills. Spectral methods may also assist with the identification of regions prospective for precious opal, or in identifying viable geology while drilling. If any or a combination of these methods result in opal discoveries within the known opal fields, they can then be applied to new regions outside of the recognised areas.

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