

## ECONOMIC GEOLOGY OF THE ANAKIE SAPPHIRE MINING DISTRICT, QUEENSLAND

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### ABSTRACT

The Anakie district in east-central Queensland is the largest of the two major Australian sapphire-bearing gem gravel mining areas. The fields were established in the late 19th century for marketing distinctive royal blue hued stones to the Imperial Russian court. Since the decline in competitiveness of south-east Asian gem gravels over the last fifteen years, the Anakie sapphires have dominated the commercial gem markets. Sapphires and zircons are the major gemstones associated with the shallow Tertiary gravels of the district. Source of the sapphires has not been conclusively demonstrated. The largest commercial field is the Rubyvale-Sapphire trend, which is famed for its blue hues. The Willows field is noted for the golden yellow sapphires, as well as large green specimens, but production of blue stones is limited and of poor colour. The Tomahawk Creek field produces the finest green coloured sapphires. Commercial mining utilizes a bulldozer trenching system. Only a few commercial claims are hand-operated vertical shafts, an approach generally associated with the casual prospector. Up to 60 feet of overburden may be excavated. Commercial recovery of the sapphires involves trummel screening, sluice washing and gravity separating with a riffled pulsating jigger.

### INTRODUCTION

Australia has two major commercial sapphire mining districts: the Anakie area of east-central Queensland and the New England area of north-central New South Wales. The production from these mining districts has substantially replaced the classic Asian sources on the world gem markets.

The ruby and sapphire mines near Mandalay, Myitkyina and Mogok in Burma have been in operation for centuries, probably predating the historical records. Thailand also ranks as a classic producer of fine gem quality sapphires from a coarse gravel belt that extends into Cambodia. The widespread sapphire bearing gravels of Ceylon and India are similarly famed, though their production has considerably paler hues. The primitive mining methods within relatively small claims, exhaustion of the gravels from centuries of excavation and political upheavals over the last several decades have resulted in a steadily declining production. This decline, however, has assured the economic survival of the two

major Australian sapphire mining districts. Nevertheless, Australian sapphires, while in abundant supply, are somewhat less desirable than their Asian counterparts. They have a tendency towards a less brilliant inky blue hue rather than the more favoured, lighter 'cornflower' shades.

This is the first of two papers on the economic geology of the Australian mining district of central Queensland, and the Glen-Innes (New England) district of New South Wales with comments on the commercial marketing system and notable sapphire gems.

#### THE AUSTRALIAN SAPPHIRE DISTRICTS

There are two major sapphire mining districts: the Anakie district of central Queensland and the New England district of north-central New South Wales. Non-commercial sapphire occurrences are reported elsewhere over widespread areas of Australia.

The discovery of the Anakie fields is attributed to a Mr Richardson, employed as a railroad right-of-way surveyor. In 1875 he collected some red zircons on Retreat Creek, 13 miles west-south-west of Anakie. Thinking they were rubies, he shipped the zircons and their gravel concentrate for gemmological testing. He failed to notice the small sapphires with the red zircons, but upon identification, Mr Richardson became one of the partners in a company to work the field for the sapphires. This original discovery site was commercially worked in 1891 by the Withersfield Sapphire Company. The company's operations soon expanded from central Queensland to beyond Armidale in New South Wales, exploring almost every creek and river gravel bed for the gemstones. By the end of the century the commercially viable zone had been extended across 28 square miles.

Sapphires have been recovered from a number of localities in the state of Victoria. They are associated with heavy mineral concentrates recovered during gold mining. Tasmania has produced small specimens associated with its tin gravels. Gem quality sapphires are rare in Western Australia, but extensive corundum and emery deposits are recognized.

The occurrence of ruby in Australia is very rare. A number of reports are on record from the early years of this century, but the validity of their identification is questionable. It is likely that most

of the specimens are actually spinel or garnet. Occasional small crystal fragments of pale pink corundum occur in the Queensland gem gravels near Sapphire, Tumberumba and Burmah. Isolated recoveries of reported ruby in Queensland have been at the Jordan Creek goldfield in the Little Beatrice River, the Henrietta Creek area, the Rocky Tate River of the Chillagoe district, Campbell Creek of the Palmer goldfield and in the Anakie sapphire district. Ruby discoveries in New South Wales and elsewhere in Australia are virtually unknown.

#### ANAKIE SAPPHIRE DISTRICT: PRODUCTION HISTORY

The Anakie area in central Queensland is the major producing Australian sapphire district. It was here that the sapphire bearing district had been shown by the end of the century to extend eastward for 12 miles, westward for 14 miles and northward for 16 miles. The small village of Sapphire (Figure 1) was the only business centre in the early years of the twentieth century, but by 1907 the influx of miners from the nearby worked out Black Bridge placer gold field settled and worked the gem gravels in Policeman Creek, 4 miles from Sapphire, and founded the township of Rubyvale. Today, the main workings cluster around Rubyvale, Sapphire, The Willows and Tomahawk Creek (Figure 1). These fields constitute the 'Anakie' district, although no sapphires are found in and around the town of Anakie itself. Rubyvale is but 12 miles north of Anakie. Anakie is approximately 200 miles west of Rockhampton.

The Anakie field was proclaimed on 3rd September, 1902, as a recognized mineral field subject to the state mining laws. The area was defined to cover 18000 acres or approximately 28 square miles. This has now been expanded to over 80 square miles within a potential area of over 400 square miles.

Initial nineteenth century production was minimal because of the lack of incentives related to low prices. Many of the smaller mines and prospects ceased production by the close of the nineteenth century, only to be revived with the establishment of regular markets for the gemstones by late in the first decade of this century. Virtually all of the Australian sapphire production in the 15 years prior to World War I was controlled by German gem merchants. Many of the early immigrant prospectors were German. The



during 1957, for example, was only a hundred dollars worth of stones. The Anakie stones are a blue-black shade that is so dark as to be 'dull' when compared to the rival southern Asian sapphires. Yet the near exhaustion of the Asian gem gravels since the mid-1960s has seen a revival of the Australian production, not only for the blue hues but also for the 'fancy' colours.

#### GEOLOGY OF THE ANAKIE SAPPHIRE DEPOSITS

The Anakie fields are extensive, sapphire-bearing alluvial sands and gravels overlying a bedrock of granite, slate, clay and sandstone sequences.

The oldest geological unit in the area is the Anakie Metamorphics, a succession of quartz-mica schists, banded phyllites, quartzites and slates. Interbedded basic volcanics occur in the northern part of the field, south of Mount Ball, and limestones outcrop between Mount Clifford and Rubyvale. The Anakie Metamorphics are generally accepted as pre-Devonian, and potassium-argon dating by Webb and McDougall (1968) indicates an Ordovician age. The Anakie Metamorphic complex is intruded by the Retreat Granite (Devonian), which in the mining district consists of sheared granites, adamellites, granodiorites and diorites, and underlies the sapphire-bearing gravels, especially on Bedford's Hill and the Scrub Lead area.

A major source for quartzitic clasts of the sapphire bearing gravels is the 'Kettle Beds', an informal sequence of orthoconglomerates and gritty sandstone recognized by Robertson (1974). The unit is well exposed in the bend of Policeman Creek north of the New Rush area. The thickness of the sequence is unknown, but is estimated to exceed 150 feet (Robertson, 1974). The beds are overlain by the Hoy Basalt to the north of the New Rush area, and over widespread areas they are unconformably deposited on the Retreat Granite. Although the Hoy Basalt is postulated to be the primary source of the Anakie district sapphires, *in situ* discovery has never been confirmed. It is predominantly a porphyritic olivine basalt that emanates as a series of volcanic vents intruding the Retreat Granite.

Policeman's Knob and Mount Pleasant are the only volcanic neck structures known within the mining district (Figure 1). Corundum has been identified in the basalt on Policeman's Knob

(Robertson, 1974). It is widely advocated that the predominant portion of the sapphires and corundum associated with the mining district is derived from eroded volcanic necks somewhere, yet unknown, in the Drummond Ranges over a hundred miles to the west. Many local miners note a general tendency for the size of their recovered sapphire crystals to increase towards the west and a few small isolated sapphire discoveries have been made on the slopes of the ranges. Infrequently, cobble-sized pieces of basalt containing embedded fragments of corundum are recovered from the district's mines, but probably represent a secondary envelopment.

The sapphire-bearing alluvial deposits are termed 'wash' by the local miners, in particular reference to the stream-washed nature of the component boulders ('billy'). The wash varies in thickness from the surface to 60 or more feet in depth locally, but over most areas it is perhaps only two to four feet thick and usually under a foot or more of topsoil. Wash near the surface tends to be mainly of quartzite pebbles, while the deeper and richer deposits are generally larger boulders amid clays. In several localities, notably the New Rush area, a second wash has been found below the wash that was thought, incorrectly, to rest on basement.

The predominant colours of sapphires throughout the Anakie district are blue and green. Blue sapphire, the commercially viable commodity, is confined to a very limited area embracing the valley of Retreat Creek, but only north of the Creek itself. The fields north of Retreat Creek, especially Freehold, Reward and Sapphire, have a high proportion of blue gems, as well as considerable green-hued stones. The blue stones predominate in the Scrub Lead area. Blue stones are also found in Boot and Kettle Creek, although Carbine Creek, the next digging area to the north, only has sapphires lacking this desirable hue. Fields immediately to the south of Retreat Creek are void of blue sapphires; the green shades predominate. The fields are Zircon Gully, Washpool, Big Poverty and Subera. They have very marginal or no commercial interest.

#### THE MAJOR FIELDS

The gem gravels that comprise the Anakie district are distributed into three major fields. The main field is an area between and surrounding the towns of Sapphire and Rubyvale, 6 and 10 miles respectively north of Anakie (Figure 1). The Willows

field is approximately 25 miles south-west, by road, of Anakie. Another major area is the Tomahawk Creek field, about 24 miles from Rubyvale in the direction of the Zig Zag Range.

The sapphire wash of the Anakie district rests unconformably on the bedrock units discussed. The gem-bearing gravels are widespread: north as far as the Clermont gold fields, east to Capalla and Taroborah, south towards Springsure and west to Alpha. They are concentrated north and south of the Anakie Range in what is called the Anakie district fields, centring around the townships of Rubyvale, Willows and surrounding creeks.

#### THE RUBYVALE SAPPHIRE FIELDS

There are five main runs of gem gravel in the greater Rubyvale and Sapphire area. These are the catchment areas of Central, Tomahawk, Boot and Kettle, Policeman and Retreat Creeks (Figure 1). Most of the early commercial production and subsequent production was confined to the wash associated with the gravel deposits of Policeman and Retreat Creeks, and especially the area within a few miles of Sapphire and Rubyvale townships.

The sapphire-bearing gravels of the Sapphire township extend from near Mount Bullock to the Rice Bowl. They are within six feet of the surface along the Sapphire-Rubyvale Road near Sapphire and to the east of the Rice Bowl area. This area, known as the Sapphire field (or Retreat Creek field) is responsible for the bulk of modern commercial production.

The Cainozoic gravels in the Sapphire area appear to lie mainly on the Anakie Metamorphics. There are three types of sapphire-bearing washes known (Robertson, 1974). The most widespread type consists of ferruginous quartzite 'billy' emplaced within a reddish clayey matrix. A more restricted second type consists of three feet of reddish gravel soil above six feet of a gravel consisting of clasts of quartzite 'billy', basalt and metamorphics within a red feldspathic sand matrix. This wash variety is the shallowest and has the nearest proximity to the Sapphire township. A third wash variety is along the southern margin of the field to the west of Sapphire, and is similar to that found in the Freehold area on Retreat Creek to the west of Sapphire. This lithology consists of up to 25 feet of 'billy' and metamorphic boulders as a densely packed framework with a matrix of clayey feldspathic sand.

The Retreat Creek area is considered among the greatest producers of the district and was one of the first areas to achieve

significant commercial attention. The main concentrates of wash, termed a 'lead', centres around the town of Sapphire, hence 'the Town Lead'. It is shallow, and its variable thickness averages only three feet. It has been extensively worked, but short-term prospecting has frequently yielded substantial results from virgin patches amid the older abandoned workings. The deep wash that occurs about a mile west of the old township has workings averaging 20 foot depths. Substantial quantities of blue, yellow and green sapphire are still being recovered from isolated unworked patches in this area as well. Prior to World War I, during the major mining boom period, the main production zone on Retreat Creek was the Town Lead at Sapphire passing eastwards into Fighting Ridge and westwards into the Deep and Bessie Leads. Nevertheless, important zones of wash were worked on the southern side of the Retreat, areas called Grave Hill, Croker and Black Soil. Above the confluence of Sheep Station Creek were Elwood's Grave (5 miles south-west of Rubyvale), the Reward Claim and the Freehold, which are sites of the initial sapphire discoveries in the district. On the northern side of Sheep Station Creek were the deposits worked at Iguana Flat and the Granite Waterholes.

The Reward and Freehold claims reached their commercial peak at the turn of the century. They were considered the largest and most valuable deposits associated with the Retreat Creek gravels.

The Reward Claim is about seven miles from Rubyvale on a road trending south-west. It is situated but a couple of hundred yards from the road about a mile after crossing Sheep Station Creek. This site was worked by the Withersfield Sapphire Company from 1891 on the site of the first discovery of the district's sapphires in 1875. The main sapphire wash is on top of the ridge, extending down both sides and trends along some of the smaller spurs. It rests on a bedrock of weathered granite. The wash has abundant 'billy boulders' that are considered by the miners to be a favourable indicator for sapphires. The original claim workings, now abandoned, cover two hundred acres of extensively excavated ground. However, it is widely recognized that considerable portions of this claim remain unmined, since the gravels under the original dumps have never been worked. A mile further down the road is the old Freehold claim of about 100 acres. The geology of the deposit is similar to the Reward.



The Rubyvale field is the extensively worked ground approximately one to four miles north of the Sapphire field (Figure 1). Modern commercial sapphire production in the immediate vicinity of Rubyvale is from a series of gravel deposits to the east of the town along both sides of the Rubyvale-Sapphire road. The mining areas are named: Scrub Lead, Blue Bird, New Rush and the Rice Bowl. Sapphires are recovered from deposits to the north-west and west of Rubyvale on Bedford's Hill, Norman's Hill and Shotgun Hill, and Policeman's Knob and Policeman's Creek.

The wash to the east of the Policeman's Knob is composed of 'billy' boulders and basalt with minor metamorphics in a clay and black soil matrix, but to the west large 'billy' boulders predominate in the clayey matrix. These wash deposits are unconformably deposited on the Anakie Metamorphics. The wash at Shotgun Hill is similar, and is also underlain by the Anakie Metamorphics. A lithologically similar wash on Norman's Hill and Bedford's Hill overlies the Retreat Granite. Sapphires were extensively mined from these deposits around the turn of the century, especially from 60 foot deep shafts on Bedford's Hill.

The wash in the immediate vicinity of Rubyvale is generally shallow between 10 and 25 feet. Along the Keilambete road to the south of the township, the depth to the wash locally exceeds 50 feet. The wash is a clay matrix generally with 'billy' boulders, angular metamorphic clasts and quartz pebbles derived from the Kettle Beds.

The composition of the wash changes significantly to the east of Rubyvale. The gravel is an assemblage of pebbles, cobbles and boulders of quartz, basalt and metamorphics within a feldspathic sand matrix. The wash is upwards of 10 feet thick and is comparatively shallow. This commercial field includes the Scrub Lead and the New Rush area, and has yielded some of the finest quality blue sapphires in the state. The wash throughout this area is underlain by the Retreat Granite, where commercial concentrations of sapphires in the wash have been trapped within the irregular surfaces of the igneous subcrop. Depth to the bedrock surface varies widely between 3 and 60 feet, but generally is within 40 feet of the surface. The basal 3 feet of wash usually has the greatest gemstone concentration.

The most important commercial sapphire-mining pursuits for the last decade have been associated with the Scrub Lead (Figure 1).

Extensive workings can be observed from the road about a mile before reaching Rubyvale on the road from Sapphire. These mines form a mile long and a quarter-mile wide belt of several dozen open-cut mines on the south-western banks of Policeman's Creek. The Scrub Lead mines monopolize the commercial production of the district because of the relatively high recovery percentage of the most desirable deep blue-hued sapphires from workings as much as 50 feet deep. The grade of stone is immediately recognizable as the 'Scrub blues', the shades of blue that are a little lighter than the Retreat Valley average. Almost the total production is a shade of blue—yellows and green being relatively rare. An infrequent sapphire specimen recovered may reach an ounce or more.

#### THE WILLOWS FIELD

The second most important field in the Anakie district is the Willows field. This area is approximately 20 miles north-west of Anakie via the Capricorn Highway, then 7 miles south-east of the highway on a posted access road into the Willows township.

The Willows field was discovered in 1918. It has been since the scene of only intermittent mining for the commercial market. Heavy mining machinery is generally restricted to the major areas of the Rubyvale-Sapphire fields to the north and is not permitted (with a few exceptions) in the Willows area. The field is presently reserved for the casual prospector and 'tourist' digger without the use of mechanized recovery methods. The field has supported earlier in the century, however, a number of professional miners with hand-dug shafts.

The Willows field does not produce the commercially valuable blue-hued gemstones, and what blue stones are found are generally too dark to be marketable. Nevertheless, the area is widely recognized as a productive field for greens, fine yellows and parti-colours. The green-colour hues do not approach perfection. Regardless of this the generally large and flawless gem material, particularly in desirable golden yellows, provides incentive for continued prospecting.

The Willows field provides the best opportunity for success for the casual digger with but few days or weeks excavating a pit by hand (Figure 2). The average casual prospector with only a pick and shovel can excavate and process about two cubic yards of wash a day. The yield may be minimal, but a reasonable expectation is

the recovery of a dozen or two small sapphires, ranging from a half to as much as 3 to 5 carats. Some collectors have dug for a week with only a third to a half ounce yield, but 20 feet away, an excavation pit may strike a small run and recover an ounce within hours.

Frequent finds of 10, 20 to 30 carat stones in green to yellow hues are notable for this field. The area is particularly famed for its golden yellow gems of a hue recognized as without rival elsewhere in the world. Such stones tend to be flawless, brilliant, evenly coloured and sizeable as well. Blue sapphires are rare at the Willows and, when found, are mostly small and with a decidedly inferior greenish shade.

There are several digging areas within the two-mile diameter Willows field. Access to the area generally initiates from the general store and caravan park within the central portion of the field, adjacent to the dam and water supply tanks. From the general store the road winds less than a mile north circumventing the dam and eastward past the Yukon claim to a large clearing several miles across. Between the Yukon claim and the clearing are several hundred yards of partially excavated ground that is popular with the casual visitor because the wash is shallow and in the shade of surrounding trees and brush (Figure 2). It is but one of a half dozen workings in the area. The sapphire bearing wash continues, as far as is known, hundreds of yards, perhaps thousands, into the cleared area. Only a few scattered wild-cat holes have been dug there, however, because of the increased overburden thickness, and also because of the lack of shade.

There are six commercial claims on the Willows field. These are permitted to utilize heavy machinery. These are still outstanding old leases, but new restrictions prohibit any more from being issued. Only the Yukon claim has any serious, though intermittent, attempt at production. Commercial success has not been encouraging because of the lack of marketable blue stones.

The Willows field is attractive to hand excavation techniques because of the thin overburden. Brown, boulder-strewn topsoil generally is 1 to 6 feet thick, generally closer to 2 feet. It overlies about a foot thickness of sapphire-bearing wash. The wash is sometimes absent or only a few inches thick, but has been observed as much as three feet thick. It is stained white by decomposed granite. Under the wash is a yellowish to brownish grey clay that persists downward to bedrock. Thickness of the underclay varies widely,



Fig. 2. Prospecting for green sapphires on the Willows field. Limited water favours the use of dry screening procedures and hand sorting at the numerous prospect pits on the field.

between 3 and 20 feet. Some prospectors excavate deeply into the underclay for a second gravel horizon, 6 to 20 feet below. This lower wash is not always present and often barren of sapphires. Most prospectors follow the wash horizons along their east-west trends, always careful to examine thoroughly the eastward (down-stream) sides of any large boulders uncovered and to process a few inches of the clayey sand under the gravel for any sapphires that may have worked downward into softer sediments.

The bedrock is generally weathered basalt, but sometimes is an overlying sandstone bed as in the caravan park area and at Steptoe Hill two miles to the north.

Quality yellow and green sapphires have been found on the sandstone ridges north of Willows, particularly the Glenalva rise about 5 miles north of Willows. The Glenalva field has a potential sapphire bearing zone approximately three miles long and a mile wide. It has a few active prospects with a limited production.

### THE TOMAHAWK CREEK FIELD

The Tomahawk Creek field is an important field in the Anakie district but is largely undeveloped. The field, like the Willows, does not have commercially viable quantities of blue coloured gems. Its green stones, like the yellows from the Willows, are reported to be the finest shade possible and are known throughout the world as 'Tomahawk greens'. Many feel that Tomahawk Creek, some 24 miles by road north-west of Rubyvale, offers the most encouraging opportunity for the newcomer to the sapphire fields. The topsoil is only inches thick and in many places the wash is exposed at the surface. The sapphire-bearing wash along Tomahawk Creek extends to Hut Creek, a distance of approximately 2 miles. Some of the best stones that have been found are associated with the Hut Creek and Costie Creek gravels. This field is relatively remote, and accessibility is difficult. Supplies must be brought in with difficulty from Sapphire or Rubyvale across a number of sharp, narrow creek crossings.

Black spinel (pleonaste, var. ceylonite) and zircon are abundant in the Tomahawk Creek gravels. Occasionally, some attractive zircons are cut from rough of this area.

The Tomahawk Creek field is accessible with difficulty and the potential is poorly known but considered significant. Undoubtedly it remains the major, but as yet unproven, sapphire reserve for future decades.

### MINING METHODOLOGY

During 1975 field studies in the Rubyvale area, most of the commercial production was from a cluster of claims a half-mile south-east of town. Virtually all of the mines are bulldozed trenching operations (Figure 3). Only a few are hand-operated underground shafts associated with the casual prospector (Figure 2).

A typical Scrub Lead commercial sapphire mine is generally a two or three man partnership. The claim operators regularly contract-hire a bulldozer and operator to trench their claim area and stockpile the wash. It is considered economical to contract-hire when needed, generally every two weeks, since bulldozers are a relatively expensive investment and not in daily use. Several bulldozer owner-operators make a reasonable income from neighbouring claims by excavating and stockpiling their wash. Each mine operator, however, has his own mechanical backhoe or front-end loader to move portions of the stockpile to the processing plant.



Fig. 3. Excavation and processing the gravel from the Scrub Lead field south-east of Rubyvale. The sapphire-bearing gravel is excavated from the pits and dumped into a sieve, sluice and pulsating jig sequence to gravity-separate the heavy gemstones.

The Scrub Lead bedrock ranges from 6 to 50 or 60 feet below the surface. The open-cut miners process this entire section from surface downward. The independent, hand-dug shaft operator, on the other hand, preferentially mines only the several feet of rich concentrate overlying the bedrock.

The stockpiles are covered with extensive sheets of plastic to insure that the gravel wash remains dry until processing. The methodology is to dry or wet screen the wash to remove the silt and sand fraction, as well as the cobbles and boulders (Figure 4). The retention size for most plants is usually between an eighth-inch and seven-eighths inch to an inch. Since the mines are generally operated as a two man partnership, one miner operates the back-how or front-end loader to move the stockpile to the screening machinery and the screened concentrate to the wash plant, while the partner processes the gravel in the wash plant. The screening operation may be either a flat bed or a rotary mechanism. A couple of cubic yards of gravel are typically dumped into a 12 foot long, 5 foot diameter, pair of rotating drums, called a 'trummel', with a system of the desired screen mesh. Some claims use a flat-bed screen shaker mechanism for separating out the large gravel and

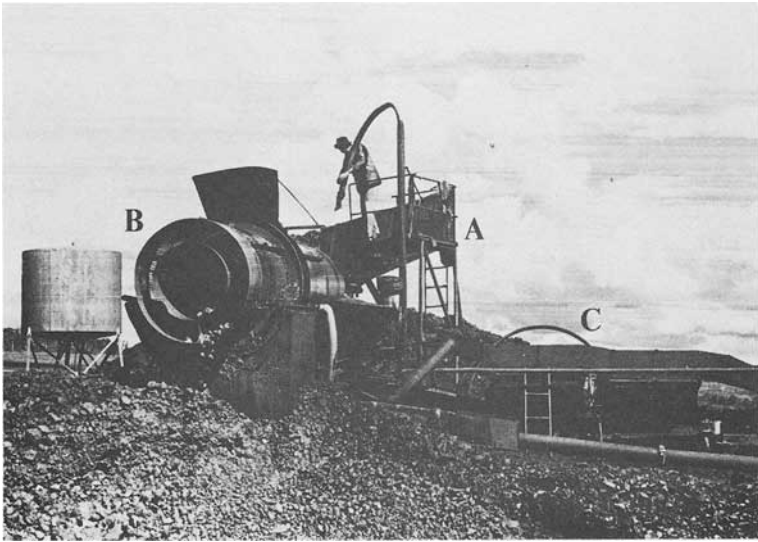


Fig. 4. Wash plant procedure to separate the sapphire-corundum-zircon concentrate.

- A. The gemmiferous gravel is dumped into a wide box, and hosed into a trummel (B).  
 B. The trummel screens the gravel and rejects the sand and very fine gravel as well as the cobbles and boulders. The retention size is generally between a quarter and an inch or two.  
 C. The slurry is then conveyed into a gravity separator. The sluice and pulsating jig mechanism traps the sapphires, zircons, corundums and other heavy minerals behind riffles.

cobble clasts. Many of the mills do not have a fines separation step, but send the gem gravel directly into the washing plant. It is only essential to eliminate the large rocks and boulders in excess of an inch or two diameter. Some plants utilize a conveyor belt to direct the gem gravel from the dry screen 'trummel' into the washing plant, but most other mines use a front-end loader to move the gravel (see Figures 3 and 4).

Washing plants in the commercial mines are essentially similar in design and only vary in size. They consist of three essential components: an open tank, a sluice and a pulsating jigger. A front-end loader at a typical Scrub Lead plant dumps a couple of cubic yards of gem-bearing gravel into a flat-bottomed steel trough, 20 feet long and nearly as wide, that is tilted forward into a 20 foot long sluice. This guides the gravel slurry into the pulsating jig (Figure 4). The jig circulates the gravel up and down in a water stream to concentrate the heavier minerals, including sapphires, towards the bottom, trapped behind riffles. A jig usually has five circulation cells but recovers most of the larger gems in the first cell and only the very small ones in the fourth or fifth.

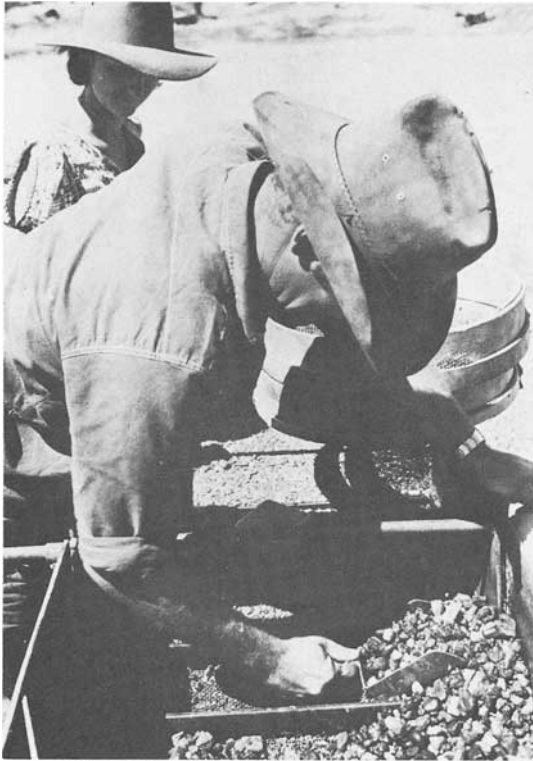


Fig. 5. The pulsating jigs on the Scrub Lead field are cleaned twice daily to recover the trapped sapphire-corundum-zircon concentrate.

The pulsator is cleaned twice a day for the concentrate by scraping the accumulated gravel with a hand trowel into buckets (Figure 5). This concentrate is hand-screened and further concentrated in a water trough and then picked through for saleable gems (Figure 6). The quantity of daily recovered sapphires varies widely throughout the Anakie district. A small two or three man claim will recover an average of an ounce or two of sapphire a day. Most of the gem sapphires are the 'Scrub Blues', a desirable light-hued royal blue, generally free of silky inclusions, as well as a smaller percentage of green and yellow sapphires. Quantities of corundum, black spinel, and considerable gem quality zircon are associated with the sapphires. The zircon portion recovered varies widely on the fields, from one ounce of zircon to four ounces of





Fig. 6. An ounce of mine-run blue sapphires from the Scrub Lead. Note the angular shapes and poorly preserved crystal and cleavage faces.

sapphire recovered to as much as equal proportions. The zircon is generally flawless, water clear to light buff brown. Large pieces, 5 to 20 carats weight, are relatively common. The zircon, however, lacks a viable commercial market. Diamonds are only rarely recovered, but not unknown.

#### NOTABLE SAPPHIRE GEMS RECOVERED FROM THE ANAKIE DISTRICT

Notable sapphire specimens have been associated only with the Anakie fields, virtually none with the New South Wales deposits. Sizeable gems, those in excess of 20 carats to as much as several ounces, usually have the non-blue colours, especially yellow and green hues. Many of these have been recovered from the Willows field. Two of the earliest known sizeable Anakie stones were found by W. Dyer: a gem of 20 grams rough in 1920 and a 1925 discovery of an orange-yellow stone that was cut to 31 carats. A notable

orange-yellow sapphire of 13 grams was found by E. Russell in 1924 on the Freehold claim, and a fine quality 14 gram golden-yellow stone was recovered in 1949 from the Policeman's Creek alluvium. *Anderson's Yellow* was a 21 gram golden-yellow sapphire found in 1949 on the Willows field by J. Anderson. The stone was first cut to a finished weight of 70 carats with an 'off cross-table' style making it the largest gem of its kind in existence. However, the cutting failed to display the gem's proper brilliance and it was subsequently recut into several stones, the largest being a double oval brilliant weighing 35.75 carats.

The *Golden Willow*, renamed the *Golden Queen*, was found in 1951 on the Willows Field by H. Clifton-Parr. It weighed 322 carats in the rough, or approximately 2 ounces. It was sold to J. McSweeney, of Toowoomba, for cutting into a 91.35 carat finished stone.

Mr Stonebridge, of Rubyvale, has recovered from his claim a particoloured sapphire of 18.4 grams. This crystal fragment, approximately two inches long and an inch thick, is a dichroic deep bottle green and a lighter greenish yellow. The gem remains in the rough but would be suitable for two sizeable finished stones, one green and one yellow. A sizeable particoloured stone weighing 78 carats, approximately a half ounce, was found by P. Robertson and P. Tanzik from a claim near Sapphire. It was nicknamed the 'Bootmaker's Foot'.

The Willows field has produced a number of sizeable, unnamed yellow-green gems between 50 and 100 carats during the last decade. An 84 carat yellow stone was recovered in 1966; a 73 carat green stone was recovered in 1975. Dozens of equally sizeable gems have also been found, many of them simply picked from the surface. Other Anakie fields also have had large stones uncovered in recent years. The Scrub Lead produced a 4 ounce yellow sapphire in 1973 and the small Divide field, upstream from the Scrub, yielded in 1975 a 4 ounce blue-yellow particolour and a 10 ounce, partly gemmy, blue sapphire.

The black star sapphires are a class of gems usually associated with the Anakie district. There have been a number of famous specimens discovered over the years. The best known of these is the *Queensland*, an enormous 1156 carat mass that was thought at first to be a 12 troy ounce piece of nearly worthless corundum. A young boy named Roy Spencer, later in life a noted gem dealer, was visit-

ing the Reward Claim near Rubyvale in 1934. He picked up the specimen and kept it at home as a door stop for many years. Black star corundum was not readily distinguished at this time from ordinary massive corundum and was considered essentially worthless. A visiting Sydney buyer to the Anakie fields later offered a few pounds for it but was refused. The specimen was later sold to the Kazanjian Brothers Lapidary firm in Los Angeles. The rough mass was cut into a 733 carat black star sapphire, more than 200 carats heavier than the famed *Star of India*.

The most renowned group of Australian star sapphires is undoubtedly the carved 'Heads of Presidents' series undertaken by N. Maness and H. Derian under the supervision of the Kazanjian lapidary firm. The four rough pieces of blue to black star sapphire utilized in the carving project averaged about 2.5 inches long, 2 inches wide and as deep. Three of these giant stones came from the Scrub Lead, and the fourth from the Iguana Flat field. The head of Abraham Lincoln is a blue star stone weighing 2302 carats rough and 1318 carats finished weight. The head of Dwight Eisenhower is a black star stone, weighing 2097 carats rough and 1444 carats finished. The head of Thomas Jefferson is a blue star-stone weighing 1743 carats rough and 1381 carats finished. The head of George Washington is a blue star stone weighing 1997 carats rough and 1056 carats finished. The most recent sizeable asteriated sapphire was found in 1973, which weighed in excess of 11 ounces.

The Willows field will undoubtedly remain the most prolific producer of unusually large stones for the near future, especially for those of yellow and yellow-green hues. With the future development of the Tomahawk Creek area, it would not be surprising to find a number of very large deep green gems on the world markets.

#### ECONOMIC VIABILITY OF THE ANAKIE DISTRICT: A COMMENT

The Australian sapphire mining industry faces two serious economic crises. The mining claims in Queensland are restricted in size to limit the viable operations to a two or three man partnership. The Scrub Lead claims, for example, are limited to a maximum of three acres. This normally contains enough reserves for three or four years of production. The laws are designed to favour the 'independent' mine operator and to prevent the monopoly of the industry by large, well-financed syndicates employing dozens of men and innumerable pieces of mechanized

equipment. This latter approach dominates the fields in New South Wales. Neither approach seems satisfactory. The small producer in Queensland is rapidly facing a land squeeze. There is considerable sapphire bearing land, more than 100 000 acres, remaining largely unworked in Queensland, but most of it is either too isolated or patchy to permit effective mechanized mining, or the land is restricted against mechanized mining in favour of hand-excavated trenches and shafts for the 'tourists' or casual prospectors, who are loath to see the areas declared commercial districts. New regulations (1976) would allow hand operators to confine their excavation to about one-quarter acres, while the machinery operators would be restricted to a four acre area, but open up grounds previously zoned against commercial development. Nevertheless, the over-mechanization in adjacent New South Wales is frequently responsible for flooding the market with an oversupply of gem material and promoting frequent recessions in the industry. Many of the large syndicates operations at best are being utilized at only partial capacity or at worst have been forced into only intermittent production.

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