KILMOT CREEK
ALCOOTA 1:250 000 Map, Section 70/5.

FINAL REPORT

Tenement holder: L A Johanssen
Baikal Homestead
PMB 41
ALICE SPRINGS NT 0872

Report compiled by L A Johanssen.

(For any complete picture of the Kilmot Creek garnetiferous sand resource this final report should be read in conjunction with that of EL7959.)
SUMMARY

During the year an assessment of the Kilmot Creek was conducted to determine if the mineral sands in the part that flows through the EL 8710 area might have any economic potential as a source of industrial gamet.

Expenditure for the twelve month period was $3,670.00
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GARNET SAND MINING - (A review of the practical aspects).

MAP 1. Portion of ALCOOTA 1 : 250 000 - Section 70/5, showing EL 7959.

MAP 2. 1 : 100 000 (Approx) map of Licence Area
LOCALITY

The Exploration Licence 8710 was situated north of the Mount Bleechmore Hills locality, (ALCOOTA 1:250 000 Geological map, section 70/5), and is accessed via well developed station roads that join up with the Plenty Highway, (Map 1). Most of the licence area is comprised of quaternary alluvium overlying lateritised and/or deeply weathered Mount Bleechmore gneisses, the exception being in the northern part where there are outcrops of units of the Langford Gneiss.

Kilmot Creek is the principal channel that drains from the Mount Bleechmore hills complex, rising in a large pound in the central section of the hills, (Webbs Pound). From there it flows northward, traversing firstly (and for about half its length) the ground previously incorporated in the exploration licence 7959, then that of the adjoining licence, EL 8710, where it joins the Mueller Creek.

Waters that fall on the Bleechmore Hills outside the Kilmot system drain outward from the center of the hills area in small gullies and creeks. They tend to flood directly onto the surrounding country and do not join together to form any larger channels. This means that Kilmot is the only sandy channel of any consequence rising in the garnet rich rocks of the Bleechmore formation, and is certainly the only creek in the locality to contain any significant amounts of garnet reserves.

PROJECT AIMS

The principal aim of this enterprise was to make an assessment of the garnetiferous sands contained in the bed of the Kilmot Creek. In the main these were, 1) its grade variables, 2) if any separation problems existed, 3) an estimate of the approximate tonnages that might be available, and 4), the overall suitability as a marketable product of any garnet derived from these sands.

It must be said however that in any mineral exploration program where a seemingly viable resource has been identified, the making of such assessments are but one part of the process to be undertaken early on. To establish a clear direction much consideration has to be given to the various practical problems that will affect this type of enterprise, and how best they should be resolved.

In the case of lifting the sand from an ephemeral stream and separating the garnet fraction, consideration must be given to such things as (for example) sand transportation, separation processes, concentrate transportation, environmental issues, and rehabilitation processes, etc. Each element of a project would have its own unique technical problems as well, but these would be subordinate to the practical matters that have to be settled first.
Because of this it was evident that an investigation of these many practical matters would be a logical adjunct to the EL 8710 garnet sands assessment. In doing this the initial aim was to identify the various problems that would confront such an enterprise, and where possible find a means of resolving them. It soon became apparent however, that in view of the parallel development of other garnet sand exploration programs in Central Australia, (and in consideration of the fact that they too must face the same problems), a much broader approach needed to be undertaken.

At the same time it seemed appropriate that people with administrative responsibilities in this area should be appraised as well, so they too can be aware of the practical difficulties in proceeding with what on the face of it seems a straight forward and simple project. For reasons of this broader perspective then the review is couched in more general terms, rather than those specific to EL 8710 or the Kilmot Creek.

WORK COMPLETED

KILMOT CREEK SAND SAMPLING PROGRAM

For the initial part of the program to assess the reserves and grade of the garnet contained in the sands of the Kilmot Creek it was necessary to obtain representative hand samples from cross-sections of the Kilmot sand-channel.

Seven sections of the creek were were sampled, comprising five samples from each section, (Map 2). These returned about 10 to12 kg per section, depending on channel depth.

SAMPLING EQUIPMENT

A hand sampling device was developed to produce a sample of the predominantly dry creek sand that had a high integrity in terms of consistent volume to depth ratio. It is in the form of a 55mm light gauge steel sleeve which is turned into the sand via a removable bar. A close fitting tube of similar construction is then inserted into the first tube, and this is used to load and remove the sample.

The first tube thus acts as a casing, isolating the dry sand outside the tube, and ensuring that the sample collected represents a true vertical section through the subject material.

The bulk sample was simply collected in a 20 litre bucket.
SAMPLES

The section samples were taken to Baikal Homestead where they were quartered, and 1kg of each was forwarded to the project geologist, (Dr S K Dobos), for assessment.

Weighed amounts of the remainder were used for hand separation tests in order to establish reasonable estimates of the garnet percentages contained in the samples. (See Table 2.)

TEST COMMENTS

The hand separated garnet concentrate from the test samples (tabled below), appeared virtually free of any other heavy minerals. All size fractions above 75 microns had a few iron-rich fragments of lateritic residue, and below 300 microns there were small amounts of magnetite. In the minus 75 micron fraction a trace of a dense colourless mineral was observed, which was possibly zircon. Very little hornblende was seen in the concentrates, which simply reflects the limited amount available to the stream from the rocks weathering into the catchment.

As regards both the sand and the garnet, the predominant grain size was in the range between 500 microns and 1600microns, this fraction accounting for slightly less than 50% of the mass of each of the samples. The largest garnet fragments observed were about 3mm to 4mm in size, but above 1.6mm the garnet values were only a few percent. Not surprisingly, the tailings fraction was essentially quartz, with a lesser amount of feldspar and a trace of mica and other light minerals.

The amount of ‘tramp’ material in the samples, (stones and gravel fragments larger than 5mm, and containing no garnet), varied between 5.2% and 3%.

MINERALOGICAL EXAMINATION

As with the concentrates from the upstream section of the Kilmot Creek on EL 7959, those from the lower section of the stream on EL 8710 were, when examined by stereomicroscope seen to contain a significant (though slightly lesser) number of garnet grains that were coated or encrusted with clayey minerals. Under higher magnification these encrustations were seen to represent cracks in the garnet that are infilled with clays, or are comprised of garnet-feldspar intergrowths in which the feldspar is partly altered to clays.

In the final reports to ELs 7696 and 7971 thin section photomicrographs of garnet in the Bleechmore Granulite clearly show the intergrown nature of many of the larger garnet grains present in the source rocks. These observations are a
serious setback to the quality aspirations for any garnet concentrates that might be produced from the sand of Kilmot Creek.

The clayey coating can be clearly felt and easily seen when the + 200μ separates are rubbed either between the fingers or on a clean sheet of white paper, and it follows that the clayey residue such a product would leave on any work surface during sand blasting operations would prove unacceptable. It is apparent as well that wet processing of the garnet concentrates will not provide an immediate answer to the problem, as it will only remove the superficial clay elements from the grains, leaving the more protected fractions to be exposed during impact-attrition with any work surface.

Ignoring the clayey grains, the clean garnet grains are quite glassy and fresh, with acceptably low inclusions. They have an excellent form factor (blocky to elongate angular) with quite high concentrations of sharp to very sharp edges. Their occurrence in a freshwater creek bed would almost certainly produce low concentrations of soluble salts, but in use these concentrates would produce measurable amounts of fine suspended solids.

CONCLUSIONS

It is self evident that in applications requiring a clean surface after sand blasting it is unacceptable to have even small amounts of clay residues remaining on the work surfaces. It follows therefore that because of this the quality of any garnet concentrates produced from the sands of the lower reaches of Kilmot Creek would - certainly in an untreated form - in no way measure up to the expectations of the market.

ENVIRONMENTAL CONSIDERATIONS

The Kilmot Creek locality is reached via a station road which runs parallel to the creek for most of it’s length, and as a result no roads or tracks needed to be established to access the sample sites.

All refuse was collected and removed, (not buried), and no timber or trees were cut down for any purpose.
ABORIGINAL CEREMONIAL AND SIGNIFICANT SITES

Shortly after the EL was granted, an excursion through the Mt. Bleechmore locality was conducted with Mr Dick Purvis, one of the specific Senior Traditional Owners of the area. He was able to reassure us that were no sites within the EL boundaries that he regarded as sensitive.

As a matter of courtesy we continued to liaise with Mr Purvis during the tenure of the Exploration Licence, and at all times kept him informed of our activities in the area.

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KILMOT CREEK
Garnet Sand Samples.
(Hand separated from 1kg of quarted sample.)

<table>
<thead>
<tr>
<th>Sample Site Number</th>
<th>By Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>12.8%</td>
</tr>
<tr>
<td>No. 2</td>
<td>10.6%</td>
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<tr>
<td>No. 3</td>
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<td>No. 5</td>
<td>10.2%</td>
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<tr>
<td>No. 6</td>
<td>10.7%</td>
</tr>
<tr>
<td>No. 7</td>
<td>9.6%</td>
</tr>
</tbody>
</table>
EL 8710

EXPENDITURE - 1996/97

SAMPLE COLLECTION
  Field trip, Toyota Landcruiser,
    (580 km @ $1.00/km.) $580.00
  Sample collection,
    (Self, 27 hours @ $35.00/hr.) $945.00

SAMPLE TESTS
  Hand separation tests $880.00

S K Dobos and Associates
  Geological Consultants $180.00

Application fees, office costs, etc. $350.00

COMPILATION OF REPORT
  (Including review of garnet sand mining operations) $735.00

TOTAL $3,670.00
GARNET SAND: THE GRITTIEST ASPECTS

(Being comments on various problems to be addressed in any operation designed to recover a concentrate from the garnetiferous sands of ephemeral streams in Central Australia.)

BACKGROUND

Erosion of the eastern exposures of the Arunta Block rocks has created from Alcoota Station eastward to Indiana and Jervois Stations what I am reliably informed are world-class reserves of almandine-rich alluvial garnet suitable for abrasive applications. This garnet, which has been derived exclusively from the Irindina Gneiss and Riddock Amphibolite, meets or exceeds all the criteria for first-grade abrasive garnet on the international market.

THE WIDER PICTURE

It is self evident that the composition of alluvial material lying in the channel of any stream will in general reflect the mineralogical and microtextural characteristics of the rock units in which the stream rises, or the source rocks once present there but now eroded. This does not necessarily occur on a one to one basis however, and the reason for this lies in the differing physical properties of the fragments weathering from those headwater rocks, be they clays, sand grains, gravels, or boulders.

Mineral grains, grain aggregates and rock fragments in the stream system are milled by the abrasive action of water transport, and depending on the actual fragment hardness, may remain anywhere between being almost complete to being almost totally absent.

Denser grains and grain aggregates will tend to move less quickly that the average particle, and if of a more resistant nature may be substantially concentrated relative to their overall percentages in the source rocks or colluvium. Clayey materials and minerals of a soluble nature may be almost totally absent, having been rapidly transported out of the system, or in closed systems, deposited in the stream terminus area.

The beds of streams originating in rocks which possess granular textures such as granulites, gneisses, and granites etc that are deeply weathered will be made up predominantly of detrital sands. If the rocks of the headwaters contain finely fractured or disseminated garnet, then the sands will contain, through natural concentration, enhanced levels of garnet.

This is exactly the situation to be found in many intermittent streams in Central Australia, in sizes ranging from less than ten metres to many tens of metres in width. In some of these channels the level of natural garnet concentration is such that it is difficult to regard it without contemplating its value as a saleable resource; it is after all, just waiting there to be collected.
Knowing that the garnet has all the desirable properties and none of the deleterious ones, it would seem that all that has to be done is simply, 1) take the sand, 2) remove the garnet, 3) replace the sand, and 4) sell the concentrate.

And indeed this is precisely so. There are however, certain other elements which intrude into the clarity and simplicity of this exciting concept, and they are not necessarily so self evident.

It is for this reason that I wish to present an outline of some of the practical matters which will have a direct bearing on the successful establishment and operation of any stream-sand mining operation proposed for this area; suggesting, where possible, options or solutions that might assist those contemplating such a project.

The items to be reviewed are divided into four principal groups, listed below under the headings:

1. Economic considerations
2. General access considerations
3. Factors of a physical nature
4. Environmental considerations

1. ECONOMIC CONSIDERATIONS

CONCENTRATING GARNET SANDS WITHOUT LOSING MONEY:
THE PRACTICAL ASPECTS.

One of the first questions to be addressed when looking at the feasibility of a garnet sand project is precisely which sort of concentrating technique would prove the most suitable. While a decision of this nature can only be made after extensive metallurgical testing, there is one part of the process that is heavily influenced by the practical considerations that must be taken into account. This is: Should it be a wet separation or a dry separation?

On the face of it the answer is simple: wet separation uses water. Water in this part of the world can be hard to come by. Any notion that a large central mill can be built where an abundant underground water supply has been established, and the sand or even a rough concentrate can be trucked to it, needs to be killed at birth. In fact, here lies the argument that dictates the use of a dry separation plant.

Garnet sand does not have a particularly high value. It is very much a low-value high-volume commodity. The sale price of a kilogram of garnet sand, (like any other commodity produced in Central Australia, be it veal or vermiculite), must carry, along with all of its capitalization and production costs, the expense of being freighted from the project site to - at the very least - somewhere halfway across Australia. Hopefully after this has been done a small surplus will remain from the sale to encourage the operators and shareholders to send more kilograms.
The *absolute key* to the economic viability of garnet sand operations will lie in the control of operational expenditure. A few cents saved per tonne of creek sand in different parts of the production process will most certainly make the difference between the success or failure of the venture.

The key to *that* lies in the location of the separation plant. And it is the answer to *this* which dictates that the mill must be dry.

Undeniably, the big blunt-end of any garnet concentrating business is the part where the sand is lifted by whatever means and delivered to the separation plant. Concentrating aside, the next biggest part would have to be putting the residual sand back again, because it *does* have to go back.

Any project based on the premise that all this material can be lifted into trucks and hauled to some distal plant, then returned to the creek minus the garnet, is doomed to drown in the expenditure haemorrhage that such an exercise would create. (should it get so far). And it would not only be the cost of the transportation that would cripple the operation.

None of the country over which vast numbers of heavy truck traverses must be made - be it savannah flood plain or hill and dale - is capable of sustaining any amount of heavy traffic without completely breaking up. Such things as road construction plant and road maintenance teams would have to be put in place. Vast quantities of water would have to be hauled for compaction purposes. Gravel or clay would have to be trucked in to bind the sand, necessitating the development of quarries, (and the development of even more roads).

It could be argued then that some sort of mobile or moveable wet separation plant could be set up and kept near the sand source, so minimising road construction and transport costs. Indeed so, but wet concentrating mills can be thirsty beasts, even with the best water cleaning and recirculation systems in place. In such a case the transport of sand would be to a large extent exchanged for water haulage. Meanwhile down in the creek the sand would still be lifted into trucks, and when treated carried back again. And don’t even think about what this would be doing to the creek bank environs as the project moves along. (A subject we shall dwell upon later.)

If the main part of the business is lifting very large tonnages of sand into a separator, then this is the place where *every economy possible* must be taken advantage of, and every possible corner cut to minimise handling. It in no lesser way applies to the replacement of the sand from whence it came.

So, if the sand handling process *is* to be optimised, how is it to be done?

The best answer has to be: By nominating from the outset the very simplest and cheapest ways any garnet concentrating operation would be able to proceed, then rethinking the layout and design of the separation plant to conform with these ideas.

In doing this it soon becomes apparent that in order to achieve an absolute minimization of the sand transfer operation, the only tenable place for the concentrator to operate, the
only place which in fact might ensure that the operation has any chance of being viable, is: In the bed of the creek.

But of course having a mill in the creek means it would have to be completely mobile.

Indeed so. Though if it has to be mobile, why not go one step further and make it self-propelled?

By the same philosophy, to shave every cent possible from the sand lifting and sand return operation there needs to be a complete abrogation of any residual mind-set about having to use loaders and trucks. These must be reduced to an absolute minimum, or wherever possible done away with completely.

So how would the sand transfer - from the bed of the creek to the concentrator, from the concentrator back to the creek - be achieved? The answer is, by the simple expedient of incorporating into the mobile separator design a large vacuuming system.

In this way the whole mobile separation plant concept can be reduced to that of a very large purpose-built, fat rubber-tyred, self-propelled and self-contained concentrating machine. And it must be fair to say that having reached this point - with the plant in the creek, and the dry sand being delivered to the plant - that there could be no reason at all (other than some metallurgical imperative) for using a wet separation process.

These are the criteria which dictate that the mill must be dry. In any case, wetting the concentrate means drying the concentrate, and drying the concentrate means added cost.

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Depending on the scale of the project the platform should consist of a large or very large four- or six-wheeled articulated all wheel drive machine, similar in layout to the articulated mine-haul trucks. The suction system would collect the sand via a long manoeuverable boom-mounted “elephant’s trunk”, (operated preferably by the driver). The garnet would be stripped and the return sand delivered to the creek well over the back of the unit, via a similar tube to that on the front, but mounted on a simple swinging boom.

The garnet meanwhile would be delivered to a hopper at the tail-end of the machine, from where it could be collected by a front end loader and transferred to a waiting truck, or more likely, a moveable steel concentrate bay.

Such a method would eliminate all requirements for water, all unnecessary handling of raw sand, reduce to possibly three the actual operating personnel, (depending on the size of the operation), and compared to any other scenario, eliminate the need to have a major roadworks plant, (and all which that involves).

It has to be said that the design and construction of a separation plant like this (or any other plant for that matter) will be in no way an exercise for the financially faint-hearted. I believe though that any plan that does not recognise the importance of the issues discussed thus far will be seriously handicapped by the weight of expenditure directed toward coping with the many problems peculiar to an operation of this nature.
2. GENERAL ACCESS CONSIDERATIONS

STREAM TOPOGRAPHY

The intermittent streams of Central Australia present themselves in many sizes and types, and are to be found in a variety of geological settings. Those containing sands rich in garnet are scarcely less diverse.

A typical garnet rich stream - if there be such - will tend to have a number of clearly identifiable channel types, and though these might vary from stream to stream they will usually follow a general sequence. It will rise for instance as a dendritic drainage system in high relief deeply weathered outcrops containing or having contained substantial areas of garnetiferous gneisses. Such a system will quickly coalesce into a main channel with numerous feeders, each of which will contribute material to the sand mix.

Further along, the stream will often drain through broad areas of lower relief hills, again with feeder channels adding garnetiferous or non garnetiferous materials. At some point the garnet rich sandy channel will either join into a much larger stream, (with its own similar or dissimilar sands), or exit the hills and flow out onto low-gradient flood plains, in many cases composed largely of quaternary alluvium deposited by the stream itself.

Whichever scenario prevails, the stream will ultimately terminate in a floodout area. Typically these are places of almost zero-gradient ground, in many cases comprised of myriad shallow scrub-choked channels that either just peter out, or in some instances drain into shallow evaporation pans.

ACCESS IN HIGH RELIEF HIGH GRADIENT ROCKY HILLS

The motivation for a sand miner to attempt accessing the upper reaches of a garnet rich stream may be strong, because while the actual sand reserves are substantially less than those to be found further downstream, the garnet grades are often markedly higher. Project access to any channel in this sort of terrain has to be carefully considered, regardless of the nature of any machinery proposed for the operation.

In most cases there will simply be no access other than that provided by the channel itself. Any idea of bulldozing a track to service such an itinerant project would be unsound both from an economic point of view, and environmentally. It would be costly to construct, and difficult to rehabilitate in any satisfactory way.

Access via the channel itself is less problematic. Even a track in dry sand will compact to a degree where a conventional tip truck can negotiate it successfully. Operational demands such as turning a vehicle around in the confines of a sandy channel would however, suggest the use of a vehicle more appropriate to the project.

Tracks pushed through boulder beds, or through titree choked channels that often separate open sand reaches would heal quickly. In the case of disturbed boulder beds, this would be as soon as the next major flow; where the titree is concerned, certainly within a couple of years.
ACCESS IN LOW RELIEF MODERATE GRADIENT ROCKY HILLS

Similar problems and conditions are to be found in country comprised of low gravel-skirted rocky hills, though as would be expected they are in no way as extreme. In this type of country the channel will generally be broader, and both the boulder beds and the titree less prevalent.

In fact where access is concerned this type of open hilly terrain in many ways presents as less problematic than other places. The tracks themselves - if the soils have a high gravel content - are able to carry more traffic than floodplain soils before they start to deteriorate; this is, after all, the material used to surface roads.

In many places - and with a little forward planning - temporary tracks can be created by simply driving a vehicle along, a grader only being required to make a way through rocky sections or gullies. Rehabilitation is straightforward as well because of the minimal disturbance. Even so, there still exists a sound argument for as much of the operational access as possible to be confined to the creek itself.

Declines giving access from the surrounding countryside to the bed of the waterway need as much as is practicable to be kept to a minimum. Given that the creekbanks will for the most part be relatively steep, those that are necessary should be sited at places where gradient and elevation differentials can be kept as low as possible.

This makes economic sense too. Steep gradients put more wear and tear on haul trucks for instance, and the construction and rehabilitation of roads with shallow gradients is less costly. Siting of access tracks in or alongside the channel of a smaller tributary or on the inside of a bend in the channel should be adopted wherever possible.

ACCESS TO CHANNELS ON FLOODPLAINS

The country through which ephemeral streams flow as they traverse broad floodplains can be surprisingly varied, and may range between areas of open savannah grasslands, dense mulga scrub, spinifex country, and in some cases regions of medium-height spinifex covered proximate sand hills derived from the reworked sands of the stream itself. The one common factor in these differing circumstances will be that the creekbanks are soft, and as a result moderately sensitive to disturbances that initiate erosion.

There are many places along these channels however where the banks are of a gentle gradient, and with the application of some well executed forward planning and a little common sense, accessing the sand should give few problems. This applies as well to those places where sand hills adjoin the channel. Geologically they are a recent phenomenon, and always occur on the side of the stream away from the prevailing wind.

FLOODOUT AREAS

No data exist nor observations made which would indicate that economic reserves of garnet sand might occur in floodout areas, so access is not an issue.
3. FACTORS OF A PHYSICAL NATURE

SAND RESERVES
The effects of stream gradients and other factors on accessible sand volume.

It can be demonstrated that in most instances a correlation tends to exist between the gradient at any point of an intermittent stream and the amount or depth of sand that remains at that point. Thus, fast flowing streams in the high relief headwater sections of a system will for the most part have shallow sand beds, while in those parts of the riverbed where the gradient is more moderate they will be deeper.

Usually in the floodout country at the end of a stream system there will be little or no clean sand. As the gradient of the main channel decreases and the water velocity becomes lower and so less turbulent, an increasing amount of the finer material transported from the headwaters begins to settle out. In these places the ratios between sand and silt are quite the reverse to that found in the sections mentioned above.

Other factors to influence the sand reserves of an intermittent stream are the presence of dense scrub in the channel, and an abundance of boulders in the sand.

Sections of thick titree scrub (and to a lesser extent eucalyptus), can occur at any point along a channel where conditions are ideal, whatever the gradient. At such a location the titree acts much like the scrub in floodout areas, slowing the water and promoting the settling out of silty fractions. In many instances this occurs in localised bands which the titree promptly colonises. At the same time narrow channels and laneways develop between the bands, and here the turbulent flow tends to keep most of the sand from settling.

In some places certain areas of the channel may be comprised of a large number of various size boulders, though this is a problem mostly confined to the upper reaches of a stream. While these rocky sections might not effect the total tonnages of sand available in any meaningful way, they could, in a situation where the sand has a very high garnet content, interfere with any operation in such a way as to render it uneconomic.

SAND AVAILABILITY
The effects on any garnet recovery project of showers, storms, and creek flows.

If there is one thing about any proposed project of this nature that has the statistical inevitability of death and taxes, it is the certainty that at some time, sooner or later, the stream is going to flow right through the middle of the mining operation. Exactly how much a given garnet recovery project will be effected by periodic showers and storms will depend largely on the nature of the machinery being used, and this applies especially to that of a mobile concentrating plant operating in a creek.
With forecasting techniques and communications what they are, major weather patterns that might require the evacuation of machinery from the creek are well heralded. Even without such things it would be rare for a storm to somehow flood the channel without any warning at all. Monitoring the weather would be an important part of an operation manager's brief, as would be the making of any decision to act.

Following an average creek flow the sand will for weeks remain damp or wet at the surface, and wet or waterlogged at depth. If a second or third flow occurs within say two months then the above conditions will prevail for a much longer period. A general rain will leave access tracks impassable for a while after the rain stops, and often they will require maintenance before any operation can recommence. The degree of perturbation will depend on the nature of the rainfall; steady rain does little damage, heavy storms much more.

This means that there will sometimes be long periods when the whole operation will have to close down, and so interrupt continuity of supplies to the market. An obvious contingency plan to meet such circumstances would be to gradually establish a covered concentrate stockpile somewhere, say in Alice Springs. By estimate, a ten-year flood event (say for example, a slow moving tropical depression that brings a general rain and heavy storms over a seven day period for a total rainfall of 250mm), might well leave a sixty day concentrate reserve fully depleted.

It is not just the intermittent flow of water that will prove an impediment to any dry separating process either. Brief storms and showers can often dampen the sand quite thoroughly, and on occasions will sweep through often enough to prevent it from drying at all. How this would effect the operations of a dry separator would depend entirely on the nature of the separation processes itself, and how it reacts to a certain amount of residual moisture in the feed material.

4. ENVIRONMENTAL CONSIDERATIONS

TREES AND TREE ROOTS

One of the more difficult environmental problems associated with any plan to excavate sand from an intermittent stream pertains to the issue of trees and tree roots. Mature trees are easy to see and easy to avoid, and care should be taken to ensure that they remain undamaged. An occasional sapling rivergum that has to be sacrificed to make way for an access track however, is neither here nor there. The principal issue is that of tree roots, and they will almost exclusively be those of the gums growing in the creek.

The Red River Gum (Eucalyptus Camaldulensis) is an excellent example of a species that has come to dominate its own particular niche. It has achieved this by developing a root system that grows not down into the deep subsoil and underlying weathered rock profile beneath the creek, but laterally from the trunk, often for considerable distances at shallow depths. By this means the juvenile tree probes along the clay at the base of the creeksand and taps into the often quite substantial supplies of water that exist there.
During a prolonged dry spell when the water supply becomes exhausted many of the rivergums become stressed and lose their leaves. In extreme conditions they often die back, or even die. This is in direct contrast to the thriving eucalypts that grow along the banks of the creek - mostly bloodwoods and ghost gums. These trees develop their principal roots straight down, and actually tap into subterranean water systems which lie ten or twenty metres down.

Any sand mining operation that were to employ earthmoving machinery to excavate the sand would, no matter how much care was exercised, inflict root damage on a large number of rivergums in the process. The difficulty of course is in predicting where exactly these roots might lie under the sand, and at what depth. Were this to be known and the roots avoided then in many places large quantities of sand would remain unaccessible to the operation.

The suction loaded mobile concentrator described earlier would inflict no such damage. Its soft edged suction snout would be able to retrieve the sand from around the radial root systems without disturbing them in any substantial way, and as the machine moved forward the sand discharge system would rebury them.

**BROWN FROGS**

Whether they are hibernating, or aestivating, or just waiting for the next creek flow, the creek sand in places can be full of them. It is doubtful whether any data exist on such things as their distribution in specific streams, what their population levels are like, or whether they populate a stream generally or tend to more specific areas.

For a frog to survive in this state of dormancy requires that a certain level of relative moisture remain in the surrounding sand, which means that the frog populations should be highest where the sand remains damp. It would be acceptable to say then that any sand which is quite dry will as a consequence be free of frogs, and so would be safe to treat for the removal of the garnet fraction.

Frog populations worldwide are in decline, and this aspect of any garnet concentrating operation could become a very sensitive issue. In this regard a vacuum-lift dry-separation operation moving on soft tyres - as suggested earlier - would be by far the better option.

The only other knowledge I have to hand about these frogs is that they are brown.

**OTHER FLORA AND FAUNA**

It must be said that in respect of a project of this nature frogs may not be the only population sensitive species to be involved. Other examples might well be demonstrated to be threatened.

It would be in the very best interests of the operators to be the ones to identify such species, and develop conservation and protection policies accordingly.
REPLACEMENT OF TAILINGS SAND

As mentioned before, it is perfectly obvious that the sand must go back into the channel, regardless of the nature of any foregoing processes. It would be a mistake though to expend too much effort in spreading it about to a degree where it resembles the situation that existed prior to the operation passing.

The reasons for this are twofold. Firstly, pushing the sand about with machinery too much would exacerbate any earlier damage or disturbance to the roots of the river gums nearby. Secondly, (and within reason), no matter how irregularly the sand was deposited, the first time the stream had a substantial flow it all would be returned to a natural state of repose.

HAULAGE OF CONCENTRATES

As mentioned earlier, very little of the country through which ephemeral creeks flow is amenable to more than a few heavy vehicles passing across it before it breaks up. In the hilly country mentioned before, and areas of floodplain where the soil is predominantly clay or clayey loam, the roads and tracks will quickly deteriorate into deep bulldusty trenches, while areas of sandy loam will simply revert to loose sand.

Even properly constructed and compacted roads can suffer this fate if the frequency of heavy vehicles is excessive. Speed too is a factor, and the results of such examples can be observed when during a dry period a large number of roadtrains are called to outlying station properties to move big herds of cattle to agistment areas. By the time such a move is complete the station access roads have often been reduced to tatters, and large sections of the main arterial roads broken-through and made very much in need of resheeting and recompaction.

The principal factor involved is the interaction between the rolling loaded tyre and the road surface, and the prime component in that is the air pressure in the tyre. This tyre pressure converts directly to the ground pressure exerted by the vehicle, which for heavy highway trucks often exceeds 700 kPa (100 psi).

In some places (depending on the soil type), the uncompacted ground will accommodate one or two slow moving vehicles that exert such ground pressures before it crumbles, but if the sand component of the soil is even of a moderate percentage the truck will quickly become bogged.

Again, to persist with this type of concentrate haulage operation would necessitate some sort of road construction and maintenance capability to be established, though certainly not on the scale that would be needed for any raw sand haulage program.

To minimise the size of the road plant needed to sustain an efficient concentrate haulage operation (and it is reasonable to expect that a project of any size would of necessity include such an element), requires that a similar approach be taken to that concerning the separation plant.
As mentioned before, on the mobile separating plant the concentrates should be collected in a hopper at the rear end of the machine, which because of space availability and loading constraints, would only hold a limited volume. It could be argued then that it might be advantageous to hold the cons in a larger capacity trailer attached to the mill vehicle. This however would seriously hinder the mobility that the concept is based on, the mobility that would be such an asset. This mobility would allow the operator to back up and reposition the unit at any time (mostly in soft uneven going), without ever having to worry about an uncooperative and wrong-headed appendage attached to the back.

To transport the concentrate from the hopper would require the services of a front end loader, but one of these universal work machines is an essential item for the project anyway.

At the other end of the operation there would be heavy road trains regularly engaged in transporting the concentrates to Alice Springs via the main roads. As these two elements do not join up it is required that something be devised to connect them. This would need to be something efficient, cost effective, and most importantly (because of the nature of the countryside to be traversed), something very light-footed so to speak, even when fully loaded. The transporter (or transporters) concerned must be able to haul the concentrates from the operation site (which could be in any sort of country, and steadily moving), to a bulk transport loading facility located adjacent to a main road or project-maintained feeder road.

As mentioned earlier, the cons need to be carried away from the mill by front end loader, and deposited in a movable steel concentrate bay, probably (but not necessarily) located outside the bed of the creek. As the project moves forward and the point is reached where a new creek access-track should be developed, then the empty bay would simply be dragged by the front end loader to the new loading site; the bay consisting of a steel floor with three low walls, all suitably reinforced.

When the special soft tyred (very low ground-pressure) haul vehicle arrives at the mill location, the accumulated concentrates would be scooped up from the bay with the front end loader and transferred to the transporter. This machine would then deliver the garnet product to the mobile elevator and covered storage bin parked in a convenient position near a main road. From the bin the concentrates would be dropped into the tipper bodies of a road train for haulage to Alice Springs.

ABORIGINAL CEREMONIAL AND SIGNIFICANT SITES

This is a well discussed subject, and most people in the mining and exploration industry (and many others) are aware of the sensitivities of the traditional aboriginal people to these special places.

The only comment I might make is that it is imperative that in the situation as discussed, management must discover the identity of the old men of the area, that is to say, the Specific Senior Traditional Owners. In most cases there will be several individuals with overlapping land entitlements and authority, but for any given locality there will be one.
senior voice. (On some occasions there will be one or two self-nominated pretenders that will want to have a say because they are politically strong.)

The best approach I have found is to seek out these gentlemen, and rather than have any sort of substantial organised meeting, simply have someone in a senior position talk to them openly and frankly about the project, then listen closely to what they have to say. They will indicate their concerns if they have any. (Aboriginal women have special places too, so during this process ask discreetly of these. The Old Men know all.)

As a natural courtesy this person should continue to liaise with the Traditional Owners whenever visiting the project. Communication is, after all, a wonderful thing.

CONCLUSION

Any project of this nature is going to be closely watched by those that might wish to stall it or halt it for what they, from their point of view, regard as environmental imperatives. I firmly believe that for the project to be successful both in an economic sense and environmentally, (and the two are inextricably bound), the issues here raised must be addressed in the fashion indicated, or at least by some close parallel.

There are no alternatives. The tonnages available might be large, but garnet sand is a very low value commodity. Every possible economy must be identified and rigorously adhered to, to ensure that the whole business does not just become a financial disaster.

Other difficulties will most certainly present themselves as an operation of this type becomes established. Because of the many unique circumstances connected with the project the principal means of dealing with such problems must be to maintain at all times a flexible and innovative approach. At the same it will be important to hold firm to strict economic disciplines, and adopt policies and ideals which are sensitive to the environment.

By these means a good result should ensue and everyone will be happy. The Department will be happy, the shareholders will be happy, and the environmentalists will be... well, less happy, but hopefully not too antagonistic.

I too will be happy, because in some small way I might have played a part in providing direction in an area I hold dear, that is to say, in the area of mineral exploration in the central area of Australia.

OK then, Two areas.