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<tr>
<th><strong>Titleholder</strong></th>
<th>Tri-Star Energy Company</th>
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<tr>
<td><strong>Operator under the Mining Act</strong></td>
<td>Tri-Star Coal Operations LLC</td>
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<td><strong>Titles / Tenements</strong></td>
<td>EL 27348</td>
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<tr>
<td><strong>Project Name</strong></td>
<td>Pedirka Basin Project</td>
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<tr>
<td><strong>Report Title</strong></td>
<td>Annual Report for EL 27348 for Period Ending 3 November 2010</td>
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<tr>
<td><strong>Author(s)</strong></td>
<td>Butler, James (Geologist) and Love, Sophie (Land &amp; Contracts Manager)</td>
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<td><strong>Target Commodity</strong></td>
<td>Coal and Base Metals</td>
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<td><strong>Date of Report</strong></td>
<td>3 December 2010</td>
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<td>Tri-Star Energy Company</td>
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ABSTRACT

This Annual Report for Exploration Tenure 27348 provides a summary of the activities undertaken on the permit since November 2009, including any results produced by these activities. This licence has recently been joined to a group of licences that were assembled to create a large area that could feasibly be exploited as a coal producing area. The area covered by the group licences will be referred to as the Project Area. Tri-Star Energy Company anticipates that it this Project Area will ultimately create a large economic mining project.

EL 27348 was granted on 6 November 2009, for a term of six (6) years and is set to expire on 3 November 2015. Tri-Star Energy Company is the sole titleholder of EL 27348 and Tri-Star Coal Operations LLC is the sole operator of EL 27348 and the Project Area.

The work program for EL 27348 during its first year required a geological and geophysical review of existing data and information towards determining the location of Permian coals within the Purni Formation and specifically, their depth, thickness, lateral extent and quality. It also required mapping activities and the determination of a drilling and/or seismic program moving forward.

Tri-Star spent considerable time in investigating and re-analysing the seismic data, water bores and other geological and geophysical data over EL 27348 and the surrounding tenures. The data was highly promising and has therefore caused Tri-Star to revise and improve the original drilling program for the Project Area, to incorporate an ironstone deposit. The ironstone formation, located in between the De Souza and Crown Point Formation, is believed to be temporally contemporaneous with the deeper Permian Purni coals to the east, which are also of great interest to Tri-Star. Office-based studies have determined that it is unlikely that the coal seams extend to the Southern area of EL 27348 and therefore, Tri-Star has voluntarily relinquished approximately 90 per cent (%) of EL 27348.

The expenditure commitment for EL 27348 for its first year required an expenditure of $65,000.00. Tri-Star Energy Company has met all work and expenditure commitments for EL 27348 for the term of the licence. The second year of the term will focus on an expanded seismic program over the Project Area and gathering core data through a revised drilling program over the Project area that focuses on both the coal and iron formations to assess their potential mineability and commerciality.

INTRODUCTION

The tenure subject to this report was granted to Tri-Star Energy Company on 6 November 2009 and expires on 3 November 2015. EL 27348 covers an area of approximately 1,022.26 square kilometres, comprising of 332 sub-blocks. EL 27348 is located approximately 58 kilometres West of Finke in the southern Northern Territory near the border between the Northern Territory and South Australia, as shown in Figure 1. This tenure is geologically located over the Eromanga, Amadeus and Pedirka Basins, as shown in Figure 2.
EL27348 Geological Region Map 2010

Legend

- EL27348

Amadeus Basin

Pedirka Basin

Eromanga Basin

Musgrave Province

0 12.5 25 50 Km

Figure 2
The topography of the permit area is shown in Figure 3. The tenures are traversed by various property access roads and tracks between the many dams and water bores. The tenures are located on the Finke 1:250,000 map sheet, the Beddome 1:100,000 map sheet and the Oodnadatta 1:1,000,000 map sheet.

Tri-Star’s exploration rationale and objectives for this tenure and the Project Area considers the evaluation of the coal potential of the Permian Purni Formation, which contains coal seams that are likely to be correlatives of Upper Permian coal measures found in Queensland’s Bowen Basin. Exploration activities are intended to locate the sub-crop edge of the Purni Formation, and Tri-Star’s activities have greatly narrowed the area in which the subcrop is located. A further drilling and seismic program has been planned over the Project Area to identify the precise coal subcrop location over the Project Area. The coal quality in the permit area and actual local lateral extent of the coals will be revealed through a comprehensive core drilling program over the Project Area.

Exploration activities on other tenures within the Project Area also uncovered a large ironstone deposit, which Tri-Star is aggressively exploring. In 2009 Tri-Star undertook a seismic survey program to delineate the shape of a large ironstone deposit. After evaluating the processed seismic sections gathered in the field program, Tri-star has concluded that the deposit does not extend to the southern area of EL 27348, and that the deposit is wholly located in west of the Project Area. The northern-most area of EL 27348, however, still remains prospective. The ironstone formation will be the focus of a drilling program over the Project Area, to evaluate the variability of the iron (Fe%) content, as well as the lateral extent and quality of the deposit. The subcrop location of iron and coal will be indicated by an extensive seismic program on the Project Area.

The exploration program for this year was aimed at identifying the location and the structure of the Permian coals and ironstones of the Purni Formation, with the ultimate goal of determining their potential for mining. Further data review and interpretation are required together with more information on the coal’s characteristics and economic potential. Encouraging coal results will necessitate the completion of preliminary mine and market investigations.

**HISTORY OF TENURES**

Exploration Licence 27348 was granted to Tri-Star Energy Company, as the sole titleholder and operator, on 6 November 2009. Tri-Star Energy has recently nominated Tri-Star Coal Operations LLC as the operator of this tenure.

The permit area of this tenure covers 1022.26 square kilometres and is comprised of 332 sub-blocks located in southern Northern Territory, west of Finke, shown in Figure 4. The permit area is located over surface lands that have not extinguished native title and which are currently comprised primarily of Perpetual Pastoral Leases, as shown in Figure 5.

The 332 sub-blocks are described as follows:
Table 1: SUB-BLOCK IDENTIFICATION TABLE

<table>
<thead>
<tr>
<th>Block</th>
<th>Sub-Blocks</th>
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<tbody>
<tr>
<td>SG531321</td>
<td>Y, Z</td>
</tr>
<tr>
<td>SG531322</td>
<td>O, P, T, U, V, W, X, Y, Z</td>
</tr>
<tr>
<td>SG531393</td>
<td>D, E, J, K, O, P, T, U, Y, Z</td>
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<td>SG531463</td>
<td>P, U, Z</td>
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<tr>
<td>SG531535</td>
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<td>SG531607</td>
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<tr>
<td>SG531679</td>
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Table 1 shows the blocks and sub-blocks of the permit area.

Tri-Star has voluntarily relinquished approximately 90 per cent (%) of EL 27348, consisting of 298 sub-blocks. Tri-Star has retained the most prospective area of the tenure, comprising of 34 sub-blocks, as shown in Table 2 below.

Table 2: SUB-BLOCK IDENTIFICATION TABLE – RETAINED AREA

<table>
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<tr>
<td>SG531322</td>
<td>O, P, T, U, V, W, X, Y, Z</td>
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5
REGIONAL GEOLOGY

The Pedirka Basin is an intracratonic basin located across the border between the Northern Territory and South Australia in central Australia, with the majority of the basin area occurring in the Northern Territory. The geologic units it contains are Permo-Carboniferous in age and are correlative with sediments of the Cooper and Officer Basins.

The Pedirka Basin section is predominantly covered by a thin section of units of the Simpson Basin, which are Triassic in age. The sections of these two basins are then in turn overlain by a thicker succession of Eromanga Basin units, which are Jurassic-Cretaceous in age. The primary structural features of the Pedirka Basin are the Eringa and Madigan Troughs, which are also the main depocentres that are separated by the McDills Anticline.

Table 3

<table>
<thead>
<tr>
<th>STRATIGRAPHIC TABLE - EROMANGA / SIMPSON / PEDIRKA BASINS</th>
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<tbody>
<tr>
<td><strong>BASIN</strong></td>
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<td>EYRE</td>
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<td></td>
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<tr>
<td>EROMANGA</td>
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</tr>
<tr>
<td>SIMPSON</td>
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<tr>
<td>PEDIRKA</td>
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Table 3 above provides a stratigraphic table of the Pedirka Basin, and the overlying Simpson (where present) and Eromanga Basins. These basins are also overlain by a shallow section of fluvial and aeolian units of the Eyre Basin, which is found at the surface.

PERMIT GEOLOGY

The tenure is geologically located over the Eromanga, Amadeus and Pedirka Basins. Within the tenure area, units of the Pedirka Basin overlie the southern part of the Amadeus Basin and the Pedirka Basin section is predominantly covered by a substantial section of Cretaceous-Jurassic units of the Eromanga Basin. It is believed that Simpson Basin units are absent from the stratigraphic section in this area as it is located west of that basin’s margin.

The topography of the permit area, highlighted in Figure 3, show that the Traceys Dam is situated near the centre of this tenure. Lilla Creek also passes through the North-Western corner of EL 27348

EXPLORATION OBJECTIVIES AND RATIONALE FOR THE CURRENT TERM

The product targets of the exploration program are the coal and ironstone measures that occur in the upper portion of the Purni Formation. Tri-Star currently holds a total of 13 granted Exploration Licences for mineral exploration in the Northern Territory. These tenures cover some of the central and western parts of the basin. Therefore, Tri-Star is currently conducting exploration for the target coals from a basin-wide perspective. The objective of Tri-Star’s exploration program on these tenures for the current year is to identify a deposit of Permian age coal from the Pedirka Basin that can be economically extracted and sold at a profit. Office-based studies have revealed that it is unlikely that the coal seam extends to the southern area of the tenure and therefore approximately 90 per cent (%) of EL 27348 has been voluntarily surrendered by Tri-Star.

EXPLORATION ACTIVITIES DURING THE REPORTING PERIOD

EL 27348 was recently added to the Combined Technical Reporting Group titled the “Pedirka Basin Project”. Tri-Star has studied a wide area of the western and southern portion of the Pedirka Basin to establish the geological framework of the Purni Formation coals and ironstones. To date, Tri-Star has reviewed an unconventional seismic acquisition program, fully reprocessed the results from the program and investigated information from available well logs and water well reports in the western Pedirka Basin. Tri-Star has further conducted extensive geological field mapping, surface sampling, lab analysis, designed a new seismic and drilling program for the Project Area and recently lodged an
updated Mining Management with the Department. In addition, Tri-Star conducted studies of the reprocessed sections of seismic gathered on the eastern edge of the basin. Tri-Star Energy Company has also recently nominated Tri-Star Operations LLC as the operator of these tenures.

These activities allowed Tri-Star to plan and develop a more extensive seismic and drilling program for the Project Area, to commence in 2011. Tri-Star has lodged a Mining Management Plan with the Department and has begun tendering the core drilling activities, as well as having already bid and contracted a seismic program.

**Background**

Tri-Star has expended considerable time in investigating and analysing available seismic data, water bores and geological and geophysical data over the Project Area. There is currently no seismic data or petroleum well data available over EL 27348, as shown in Figure 6. There is, however, available seismic data available just outside of the tenure area, to the North and North-East of the tenure. Tri-Star reviewed its analysis of previous seismic data in the surrounding areas, derived from Tri-Star's seismic acquisition activities carried out in February 2009. The reprocessing and review of this data has facilitated the production of coal maps of the tenure area and has forced Tri-Star towards a revised direction and location for further drilling and seismic acquisition over the Project Area.

Tri-Star's fundamental objectives and rationale expanded, as exploration results have vastly increased the scope and potential for this region. The discovery of Permian ironstones at the surface of the Project Area are encouraging indicators that justify expanded fieldwork activities and Tri-Star remains committed to progressing exploration activities over the Project Area. This analysis and other office-based studies, however, have revealed that it is unlikely that the coal seam extends to the southern area of the tenure, and therefore Tri-Star has voluntarily relinquished approximately 90 per cent (%) of the tenure.

**Investigation & Analysis**

Tri-Star initially applied for EL 27348 on the basis of its understanding of the surface geology, as shown in Figure 7, and designed a staged work program to confirm Tri-Star's geological concept of the remote area and explore for commercial Purni coals. EL 27438 is generally covered with outcrops of the Carboniferous Langra sandstone and the Permian/Carboniferous Crown Point Formation. Tri-Star's target formation was, and continues to be, the Early Permian Purni Formation, as this is the only coal-bearing formation in the Pedirka Basin. Since the Crown Point Formation outcrops should be stratigraphically adjacent to the Purni Formation, areas containing these outcrops may contain shallow subsurface Purni coal Formations. This was the exploration rationale for EL 27348 as Tri-Star commenced its work programs in the Project Area.

After the first program of field activity, which was focused on seismic, Tri-Star initially concluded that the Purni Formation extended much further west than originally anticipated. Therefore, EL 27348 became a target area for the subsequent work program. Since the Purni Formation outcrops appear to terminate to the east or northeast of EL 27348 and because the seismic results show a decreasing thickness as the Purni comes updip out of the basin, Tri-Star has concluded that the Purni Formation does not extend as far west as the southern area covered by EL 27348. Therefore, Tri-Star has...
decided to relinquish approximately 90 per cent (%) of EL 27348 (298 sub-blocks) and retain 34 sub-blocks, as these remaining sub-blocks are closer to the potential economic zone.

**SEISMIC DATA**

Tri-Star Energy Company, during the first year of EL 27348, expended considerable time in reprocessing and analysing available seismic data over the tenure areas surrounding EL 27348. Its review of seismic data has facilitated in the production of maps of the tenure area. This analysis further assisted in revising the direction and location for further drilling and seismic acquisitions programs over the Project Area.

The seismic data that was analysed is indicated in Figure 6. There is currently no seismic data for EL 27348. The seismic data was acquired by an Australia Company, Velseis Pty Ltd, during Tri-Star’s exploration program over other tenures in the Pedirka Basin Project in February 2009. This program was the first seismic survey conducted over the northwestern part of the Pedirka Basin. Upon analysis of the seismic data and available outcrop sample data from other tenures, Tri-Star surmised that the reflective zones represented subsurface ironstone bands and based on this new interpretation, Tri-Star altered its scoped of work over the Project Area to include this newfound mineralised zone.

The initial results of the new data appear to contradict previous exploration in the Pedirka Basin and suggest that the irregular feather-edge of the Purni Formation and its contained coal does not crop out at the location as interpreted in the Simpson A and Simpson B Reports. Instead, a resistive ironstone zone composed primarily of goethite was cropping out on the surface to the east of EL 27348, and was likely deposited in a swampy depositional environment on the peripheral edge of the basin. This discovery altered Tri-Star’s perception of the stratigraphic column in the area, as it appeared that the ironstone is temporally contemporaneous with the deeper Permian Purni coals to the east. Tri-Star’s Seismic Acquisition program for the Project Area will continue in 2011.

**WATER BORES**

Tri-Star reviewed the available geological and geophysical data that it obtained from previous drilling completed in the Eromanga Basin aquifers and while the water bore data did not substantially assist Tri-Star in relation to coal, the data has been of great value while searching for the newly found iron mineralisations. When Tri-Star initially reviewed the water bores it found that because the wells were quite shallow, none of those water bores intersected the Purni Formation. On Tri-Star’s review, the wells have proven to substantially assist Tri-Star in its search for the boundaries and depths of the iron mineralisations. In particular, the water well logs of RN004270, RN004266, RN004374, and RN007397 describe a ferruginous matrix that is analogous to samples collected as the surface. This has led Tri-Star to conclude that its earlier seismic program carried out in February 2009 and these water wells are indicators of a large, shallow, subsurface ironstone deposit.

After reviewing the data, Tri-Star Energy Company began moving towards revising its drilling program to test both the iron and coal deposits over the Project Area. Tri-Star sought the advices of various consultants both in Houston, United States of America and in Brisbane, Australia. The data
obtained from the water bores in relation to the iron mineralisation assisted Tri-Star in its revised drilling program.

**GEOLOGICAL & GEOPHYSICAL DATA – PROJECT ASSESSMENT**

Tri-Star commissioned an independent report to comment on the current and future prospectivity of the iron discovery. Tri-Star engaged Mining Associates Pty Ltd to conduct a “Project Assessment”. Mining Associates produced a report dated 7 July 2010, titled “Project Assessment – Iron Mineralisation – EL24899/EL24900/EL24901/EL24902/EL24903/EL24904/EL24913/EL24914/EL26045/EL27218/EL27219/EL27347/EL27348 – Pedirka Project – Northern Territory” (see Attachment 1). The report recommended that further drilling work be planned to delineate the size of the subsurface deposit and its quality and variability over distance. Tri-Star has since planned a new exploration drilling program to test both the iron discovery and continue work on the coal.

This report reviews the exploration results of activities conducted by Tri-Star over the Project Area and provides conclusions and recommendations in relation to the future development of the iron ore and coal deposits discovered by Tri-Star. Tri-Star has since planned a new exploration drilling program to test both the iron discovery and continue work on the coal, over the Project Area.

**Mining Management Plan & Risk Management Plan**

As Tri-Star Energy Company is moving towards carrying out its revised drilling program to test both the iron and coal deposits, it was necessary for Tri-Star Energy Company to amend its Mining Management Plan lodged with the Department of Regional Development on 4 August, 2009. Tri-Star has recently lodged an amended Mining Management Plan, encompassing EL 27348, with the department to include its revised drilling program and seismic activities.

An amended Risk Management Plan has also been lodged with NT WorkSafe to take into account the change in activities. The amended and updated Risk Management Plan was lodged with NT WorkSafe on 1 July, 2010.

**ACTIVITIES ON THE SUBJECT TENURES FOR THE NEXT 12 MONTH PERIOD**

**Seismic Acquisition Program**

Tri-Star Energy Company has developed a seismic acquisition program that currently extends some 82 kilometres north-west to south-east across four (4) separate lines, north of Finke. This program is designed to determine the location of the Purni Formation subcrop edge within the Project Area and to identify the depth at which the coal bands end and the possible iron deposit starts. A decision will be made on the field either during or after the seismic acquisition program whether to conduct further seismic data to identify the coal parameters.
Tri-Star Energy Company has tendered for this program and has received response in relation to its tender. Tri-Star hopes to award the contract within the first half of the next twelve (12) month period.

Iron & Coal Drilling Program

Tri-Star Energy Company has sent requests for Expressions of Interest to a number of drilling contractors and is still in the process of receiving responses. Tri-Star Energy Company anticipates that it will have a secured contract with a competent drilling contractor during the next twelve (12) month term and begin its drilling program. Pending the results of its drilling program, Tri-Star Energy Company will then consider defining parameters of any deposit identified by Tri-Star Energy Company.

Geological Field Mapping, Sampling & Literature Reviews

Tri-Star Energy Company will carry out further geological field mapping and sampling within the Project Area, including EL 27348, over the next twelve (12) months. Tri-Star Energy Company will gather additional samples for testing where necessary.

Tri-Star will further continue and expand its literature reviews and data base compilation during the next twelve (12) months of the tenure.

REPORTS LODGED FOR THE SUBJECT TENURES DURING THE REPORTING PERIOD

No reports for this tenure were lodged during this first year. Tri-Star believes that there were no reports were required to be lodged since EL27348 was granted to Tri-Star. Tri-Star will lodge a Relinquishment Report as required in due course with respect to this tenure.

CONCLUSIONS

Tri-Star Energy Company has made great progress towards locating the coal subcrop of the Permian Purni Formation coals, as well as identifying their depth, thickness, lateral extent and quality through field operations and office-based studies during the reporting period.

Tri-Star conducted office-based studies including the processing and reprocessing of the available seismic data surrounding EL 27348 obtained from field operations over other tenures in the Project Area, water well analysis, gathering seismic and well data from South Australia, further extensive geological mapping and research of previous exploration data.

Tri-Star Energy Company has designed a seismic acquisition program, to determine the location of the Purni Formation subcrop edge within the tenures which is intended to identify the depth at which the coal bands end and the possible iron deposit starts. Over the next 12 month period, Tri-
Star intends to award the contract for the seismic program, secure a contract with a competent drilling contractor and begin its drilling program. In addition, Tri-Star will carry out further geological field mapping and sampling within its tenures and gather additional samples for testing where necessary. Pending the results of its drilling program, Tri-Star Energy Company will then consider defining parameters of any deposit identified by Tri-Star Energy Company.

Office-based studies in relation to this tenure and over the Project Area have indicated that the Purni coal likely do not extend into the southern area of EL 27348. Tri-Star Energy Company has therefore voluntarily surrendered approximately 90 per cent (%) of the tenure area and has retained the most prospective 34 sub-blocks (approximately 10 per cent). Tri-Star Energy Company has met all work and expenditure commitments for EL 27348 for the first term of the licence.

BIBLIOGRAPHY


PROJECT ASSESSMENT - IRON MINERALISATION
EL24899/ EL 24900/ EL24901/ EL24902/ EL24903/ EL24904/ EL24913/ EL24914/ EL26045/ EL27218/ EL27219/ EL27347/ EL27348

PEDIRKA PROJECT - NORTHERN TERRITORY

Prepared by Mining Associates Pty Limited
For
Tri-Star Energy Company

Authors:
A Vigar, BAppSc, FAusIMM, MSEG
T Woodward, BSc, M.Sc., MAusIMM, MAIG
G MacDonald, BSc Hons (Geology), MMEE, MAusIMM

Effective Date: 07 July 2010
1. EXECUTIVE SUMMARY

Mining Associates ("MA") have reviewed the exploration results of activities conducted by Tri-Star Energy Company ("Tri-Star") on their Pedirka Project tenements in the Northern Territory.

MA has reviewed this work and concluded that exploration to date has identified an iron laterite-type deposit which may be related to the historic ochre deposits located at Rumbalara Mine some 20 km to the northeast. The subsurface extent and surface continuity is subject to confirmatory drilling and additional surface mapping.

During their initial coal exploration program in 2009, Tri-Star had sampled an outcropping ironstone layer at the base of the Da Souza Sandstone which is interpreted to extend to depth being correlated with a seismic reflective boundary.

Tri-Star has collected samples from an outcropping unit of goethitic ironstone grading up to 48% Fe. Tri-Star have interpreted that the ironstone unit could extend some 120 kilometres along strike with possible subsurface extent of 120 km x 30 km based on the seismic and water bore log interpretations. This is a large area with the potential to contain a major resource tonnage.

MA would also suggest that due to the remoteness of the region, the lack of existing infrastructure and the requirement for ore beneficiation, a substantial deposit would need to exist to justify the high costs of development and ore transport. In addition, the relatively high content of phosphorus (up to 0.59% P) will require specialist beneficiation to lower the P content to industry requirements. The metallurgical technology to remove P from goethite is undergoing study by the CSIRO but this new process is not currently available. However another Australian explorer has demonstrated P beneficiation is possible using available processes.

Tri-Star’s work to date has also identified the existence of coal seams within the basin. Any coal discovery would improve the potential for developing any iron deposit as a local power source for beneficiation and shared development of infrastructure.

The average iron ore grade from all samples is less than 40% although the highest grade of 48% is encouraging. The samples have high silica and relatively high phosphorus assays indicating that beneficiation will be necessary to bring the material to current market standards.

If an iron ore resource of sufficient size were to be outlined, MA would suggest that there are a number of aspects which would be positive for the future development of the resource:

- It is possible with the on-going work by CSIRO that in the future, beneficiation for removal of phosphorus content will become an economically viable process.
- Any processing of ore would be assisted by the discovery of minable coal (which is known to occur in the Pedirka Basin) providing a potential energy source for iron ore beneficiation and access to shared infrastructure.
- In terms of location, although the Pedirka project area is remote, it is only 150km due east of the Darwin to Adelaide rail link, a transcontinental transport route stretching from the north to the south of Australia.
- There have been discussions of an alliance among iron ore juniors working on the Eyre Peninsula, South Australia for developing or expanding deep water facility port access; such an alliance would be positive for the Pedirka project.
The current market view is for long term (+10 years) continued growth in global iron ore demand due to the escalating global modernisation, particularly in China. Given this growth outlook, any substantial iron ore discovery in the Pedirka Project area has the potential to be upgraded to iron ore reserves in the future.

MA recommends the following activities as part of Tri-Star’s on-going exploration to increase the knowledge base of the Pedirka iron mineralisation:

- A shallow drilling program would quickly determine
  - the validity of the seismic interpretation
  - the validity of the water bore log descriptions
  - the thickness and potential areal extent of the iron rich unit
  - the grade and mineralogy of the mineralisation
  - the lateral variations in quality and thickness.

- Detailed sampling and geological mapping of the ironstone outcropping areas including the Rumbalara ochre deposits.

- Metallurgical study of surface and subsurface ironstone material to determine beneficiation requirements.

An additional drilling target would be the Purni coal sequence which has been previously intersected in drilling by petroleum explorers elsewhere in the Pedirka Basin.
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2. INTRODUCTION

2.1. Nature of the Brief
Mining Associates ("MA") was commissioned by Tri-Star Energy to review the exploration results for their Pedirka Project in the Northern Territory, and in particular to give an opinion on the significance of the iron rich outcrop sampled which has returned assays up to 48% iron.

2.2. Scope of Work
MA’s brief was to conduct a desktop review of Tri-Star’s exploration results for their Pedirka Basin Project in the Northern Territory. The review was not a technical due diligence and it is intended as an internal document.

The scope of work consisted was:
- to review Tri-Star’s available and relevant technical data in connection with its iron ore project in the Northern Territory to be conducted as a desktop review of the project geology;
- to review iron ore processes and market issues related to the project ore quality;
- to provide an opinion of the iron ore quality in the current market and future market;
- to advise and provide an outline of aspects which will alter and improve the project’s success
- to provide a Memorandum on the same (this Report).

2.3. Limitations
The opinions expressed in this report have been based on information supplied to MA by Tri-Star, its associates and their staff. MA has exercised all due care in reviewing the supplied information. MA has relied on this information and has no reason to believe that any material facts have been withheld, or that a more detailed analysis may reveal additional material information. MA does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them.

MA has not visited the project site or conducted independent sampling or testing to verify the supplied data.

3. PROPERTY DESCRIPTION & LOCATION

3.1. Property Details
The Tri-Star tenements which make up the Pedirka Basin Project are a group of 13 contiguous Exploration Licences located in the Northern Territory adjacent to the South Australian border and which surround Finke and Charlotte Waters. They lie approximately 160 km southeast from Alice Springs and 90km east southeast of Erldunda on the Stuart Hwy-Lasseter Hwy junction.
Figure 1: Pedirka Basin Tenements

Table 1: Pedirka Project Tenements

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3.2. Location & Access

The project area is located 160 km south southeast of Alice Springs and is accessed by the Finke Road, 145 km east of the junction with the Stuart Hwy at Kulgera to the aboriginal settlement of Finke. There is also an airstrip at Finke. Direct access is also possible by the Ghan Heritage road from the northwest. There are various roads and tracks within the project area as illustrated in Figure 3.
3.3. Climate & Landforms

Climate

The climate is hot and dry in summer when average temperatures range from 23 to 37°C. Winters are short and cool to mild with average temperatures of 19°C. Rainfall is extremely low and unreliable averaging approximately 250mm per annum; mean annual evaporation is
4000mm (157 inches). Average temperature and rainfall data for Kulgara, NT are shown in Figure 26.

Figure 4: Monthly Average Climate Statistics, Pedirka Project Region
(Source: Australian Bureau of Meteorology)

Landforms and Native Vegetation

The area is dominated by gibber plains and slopes, silcrete capped mesas, low escarpments and ridges and sand dunes. Sandy floodplains and drainage channels associated with a number of major ephemeral creek lines dissect the landscape. The region is broadly characterised by small mountain ranges, well-wooded rivers and creeks, salt lakes, and plains of calcareous tussock grassland, spinifex and acacia shrub land. Sandy plains and dune fields border the project area to the east and west with prominent mountain ranges occurring in the north and extensive gibber plains to the south.

The vegetation of the area is characterised by sparse low shrubs on the plains slopes, mesas escarpments and ridges. The floodplains and creek channels support a low woodland of eucalypts and acacias. The native vegetation has been grazed by cattle, kangaroos, feral donkeys, rabbits and horses.

3.4. Infrastructure

The principal land use in the region is pastoralism with cattle grazing and Aboriginal land management. The closest major population centre is Finke with a permanent population of between 150 and 300.

The area is sparsely populated. The major transport corridor, the Stuart Highway, which is an artery between Adelaide and Darwin, lies just west of the Project area.

Infrastructure within the project area is minimal. The former railway dissects the project area and there are a number of tracks. There is a police station at Kulgera with an airstrip, located about 145km west of Finke. The only infrastructure at Kulgara is the Police Station Complex and the Roadhouse, which has a transient staff of about 14. There are four Roadhouses in the area, Kulgera, Erldunda, Mount Ebenezer and Stuart’s Well.
4. GEOLOGICAL SETTING

4.1. Regional Geology

The Tri-Star tenements occur along the southwest margin of the Mesozoic Eromanga Basin, which forms part of the Great Artesian Basin. Superficial sand and alluvium overlie the continental and marine sediments of the Eromanga Basin. The continental sediments of the northern part of the Late Carboniferous to Permian Pedirka Basin underlie the Eromanga Basin.

The Jurassic-Cretaceous Eromanga Basin consists mainly of terrestrial sandstones (Algebuckina Sandstone, Cadna-owie Formation) overlain in the south-eastern corner of the Northern Territory by marine sediments (Bulldog Shale).

The Algebuckina Sandstone consists of fine to coarse-grained cross bedded quartzose sandstone with pebble layers and shale interclasts common in the coarser beds. Minor lenses of siltstone and shale are locally developed. A braided fluvial environment of deposition is interpreted (Moore, 1986). In the Northern Territory this unit is mapped as De Souza Sandstone (Edgoose et al., 1993).

The Permo-Carboniferous formations of the Pedirka Basin are present in the subsurface and crop out on the basin margins in the Northern Territory. The lowermost unit (Crown Point Formation) consists of fluvioglacial and glaciolacustrine sediments. The overlying Purni
Formation was deposited in a floodplain environment containing meandering river systems and extensive swamps where coal accumulated.

In the inland, during the Jurassic and Cretaceous, crustal down warping was initially accompanied by the deposition of a very widespread fluvial and lacustrine to marginal marine clastic blanket, largely Algebuckina Sandstone and Cadna-owie Formation in outcrop, in the Eromanga Basin. Porous sandstone in these sediments forms the aquifer for the huge Great Artesian Basin water resource, and is a major petroleum reservoir where the Eromanga Basin overlies the Cooper Basin, the source of the oil and gas. In the interior, cold, arid phases were times of sand dune building and evaporitic playa deposition, and alternated with periods of moister climate, increased stream discharge and greatly extended lake systems, when extensive alluvial and fluvial sand, clay and gravel were deposited. Periods of weathering have formed hard carbonate soil profiles (calcrete) and a variety of solution features such as caves in carbonate rocks.

The following description of the stratigraphy of the Pedirka Basin is selected in most part from Middleton et al (2005):

*The stratigraphy of the Pedirka Basin, and the overlying Simpson and Eromanga basins, is shown in Figure 6. The Purni and Crown Point formations are commonly encountered units in the Pedirka Basin. Two other units, the Mount Toondina and Stuart Range formations, tentatively identified in drill hole Mount Hammersley-1, (in South Australia) have been interpreted to also reside in the deeper parts of the basin and have equivalents in the Arckaringa Basin to the southwest. Triassic formations, encountered in the eastern part of the Pedirka Basin region, are classified as being in the Simpson Basin, and Jurassic–Cretaceous formations are referred to the Eromanga Basin. Underlying all of these superimposed basins is the Proterozoic to Devonian Warburton Basin, equivalent to the Amadeus Basin, which hosts the Palm Valley and Mereenie petroleum fields further to the west.*
Variation between Permo-Carboniferous sedimentary rocks in the western Pedirka Basin is shown in Figure 7, which shows a wireline log correlation from Hale River 1 to Mount Crispe 1. It should be noted that seismic data suggests that the Permo-Carboniferous section may be up to 1000 m thicker in the Madigan and Eringa troughs (Mount Hammersley-1 is in the deep Eringa Trough) than the equivalent section in the McDills Anticlinal Trend (Etingimbra 1). This greater thickness may represent: (a) a significantly greater Purni Formation thickness than observed at Colson-1, where it is only about 200 m thick; or (b) a section similar to that in Mount Hammersley-1, which contains two Early Permian units that are not observed in other wells, or (c) a much thicker Crown Point Formation section than elsewhere encountered, although this latter alternative is presently considered the least likely.

The deepest Permo-Carboniferous formation in the Pedirka Basin is the Crown Point Formation, which is over 347 m thick in Mount Hammersley-1 (Figure 7). This formation is glaciogene at its base, with extensive development of conglomerate. Many of the sandstone units, which make up the bulk of the formation, are silty; there is evidence for lacustrine deposition and strong evidence that sediments throughout the Crown Point Formation were deposited under glacial or periglacial conditions...

The overlying Purni Formation appears to change significantly in composition from Colson-1 to Etingimbra-1 and McDills-1, which are located some 75 km to the west (Figure 5 and Figure 7. At Colson-1, the Purni Formation is comprised dominantly of shale, siltstone, coal and minor sandstone; the sandstone/shale (+siltstone) ratio is 0.13. At Etingimbra-1, the sand/shale ratio is approximately 0.50, but it appears from the interpretation of seismic data that as much as 80% of the Purni interval is missing in this well... Accordingly, there is evidence from exploration wells to suggest that the Purni
Formation becomes sandier both to the west and southwest of Colson-1. Further, there is evidence that glacial-derived sediments also exist in the Purni Formation, especially in the western part of the basin. Little is known of the extent of the Triassic Peera Peera Formation (the overlying Simpson Basin unit) in the western part of the Pedirka Basin. In Colson-1, the Peera Peera Formation is interpreted to be 35 m thick and is an interbedded shale and sandstone unit. It is absent in both McDills-1 and Etingimbra-1. It may be reasonable to assume that the Peera Peera Formation was deposited across the whole region, but eroded on the McDills Anticlinal Trend, where exploration drilling has occurred.

![Diagram of stratigraphic section]

**Figure 7:** Wireline log correlation from Hale River 1 to Mount Crispe 1, Pedirka Basin Including Petroleum bore hole locations (Source: Alexander et al. 1999)

It is also of value to briefly describe the overlying units of the Eromanga Basin... The Early Jurassic Poolowanna Formation consists of sandstone, shale and coal. Based on limited well intersections, this formation appears to consist of two sedimentary cycles over much of the Pedirka Basin and also the Simpson Basin....The shallowest formation considered relevant within the context of the Pedirka Basin petroleum system is the Algebuckina Sandstone [=Da Sousa] of Middle to Late Jurassic age. The formation consists dominantly of sandstone with minor shale, and is interpreted to have been deposited in a braided fluvial environment. It is overlain by dominantly shale-rich Early Cretaceous units. Oil shows were detected throughout the Algebuckina Sandstone in Colson-1. On seismic data, channels, possible braided stream deposits and other sedimentary features associated with fluvial systems are commonly evident....
The Pedirka Basin exhibits two dominant north–south-trending structural lineaments [underlying the Tri-Star tenement areas]: the McDills Anticlinal Trend in the western part of the basin, and the Border-Colson Trend near the eastern margin of the basin (Figure 9). These trends are essentially controlled by reverse fault systems and exhibit associated growth anticlines. The extent of structural reversal on the McDills Anticlinal Trend is shown on seismic line A85NT-01 (Figure 8). Based on the seismic interpretation, the sense of movement on the McDills Anticlinal Trend is a reverse movement to the west. In contrast, the Border-Colson Trend is reverse movement to the east. This structural configuration suggests that compressional stresses were applied in an east–west direction across the basin during various periods of the basin's development.
Figure 9: Pedirka Basin showing major structural features, well locations and quadrants
(Source: Middleton et al., 2005)

Figure 10: Location of seismic lines and petroleum wells, western part of the Pedirka Basin.
(Source: Middleton et al., 2005)
4.2. Local Geology

Within the Tri-Star tenements, superficial sand blankets contain gently south-east dipping Jurassic-Lower Cretaceous sandstones and shales which overlie highly weathered Permian sandstones of the Crown Point Formation/Purni Formation (Figure 11 and Figure 12). Where there is outcrop above the Quaternary sands, shales and siltstones of the Rumbalara Shale overlie De Souza Sandstone which in turn unconformably overlies the white sandstones and silty kaolinitic sandstones of the Purni Formation.

The De Souza Sandstone (equivalent of the Algebuckina Sandstone) consists of gently south-east dipping cross bedded medium grained kaolinitic sandstone with minor siltstone interbeds and pebble conglomerates, derived locally from Musgrave Block granite.

Figure 11: Local Geology
(Source: BMR 1:250k sheets Finke, Hay River, McDills, Rodinga 1963-68)
The outcropping ironstone deposits discovered by Tri-Star are believed to occur at the base of the De Souza Sandstone, probably at an erosional break. The ironstones are underlain unconformably by kaolinitic sandstones of the Crown Point Formation/Pumi Formation.

North east of the ironstone outcrops discovered by Tri-Star a band of yellow ochre has been mined at the historically significant Yellow King and Yellow Queen Mines at Rumbalara. The 0.75 metre wide band of yellow-brown ochre, containing 45-55% Fe₂O₃ in a matrix of kaolin, quartz and muscovite, occurs on the unconformity at the base of the early Cretaceous Rumbalara Shale.
5. DEPOSIT TYPES

Iron mineralisation which is mined as iron ore mainly occurs as sedimentary deposits, of which there are 3 main types.

- Banded/Bedded Iron Formations (BIF)
- Channel Iron Deposits (CID)
- Detrital Iron Deposits (DID)

Banded Iron Formation ("BIF"), also called Taconite is a sedimentary formation. The iron minerals are hematite, magnetite and goethite. Magnetite BIF is of lower grade and requires beneficiation. Hematite BIF is the higher grade and requires little or no beneficiation.

Channel Iron Deposits ("CID"), also referred to as Pisolite. They consist of goethite and hematite and are lower grade and usually require beneficiation.

Detritals ("DID") also referred to as Canga and Scree consist of eroded remnants of BIF, clay + iron ore (magnetite and haematite BIF). These generally require beneficiation to remove clay/shales.

Less common are iron ores sourced from non-sedimentary styles:

- Magmatic type where magnetite forms within cooling magma chamber in a layered ultramafic intrusion in the similar process that also forms chromium, platinum deposits
- Skarn –contact metamorphism where magma comes into contact and reacts with surface rock. This process also forms tin, tungsten deposits.
- Mineral sand deposits which are modern day and historical beach sands
- Iron laterites (ferricrete) dominantly composed of goethite, formed through leaching of iron rich source rocks in the same process that forms bauxite and nickel laterites (Young 2009).

Ferricrete crusts sporadically distributed on highland surfaces are interpreted dominantly as remnants of iron-impregnated sediments of ancient valleys. The great but variable thickness of kaolinised bedrock beneath the highland surfaces is considered by Milnes et al., 1985 to be the integrated product of leaching and weathering throughout the Mesozoic and Cenozoic. Deep weathering near unconformity surfaces has resulted in widespread silicification and redistribution of iron.
5.1. Iron Ore Deposits of the Northern Territory

The Northern Territory contains small to large iron ore deposits that produced about 9 Mt of iron ore between 1967 and 1974. As of 2007, resources for the NT were estimated at 300 Mt of iron ore.

Most of this occurs as low-grade oolitic sedimentary deposits (Hodgson Downs, Deposits B and C) in the Roper River district of the McArthur Basin. These haematite-rich oolitic beds are 0.5 to 4 m thick and Mesoproterozoic in age.

The following descriptions are derived from the abstract of Ferenczi PA, 2001 on the iron ore, manganese and bauxite deposits of the Northern Territory.

Iron ore occurrences in the Northern Territory have been classified into four types: oolitic sedimentary, hydrothermal, Fe-skarn and surficial.

- **Oolitic sedimentary**: the Mesoproterozoic iron ore deposits of the Roper River iron field (McArthur Basin) are examples of the first style. These oolitic ironstones form 0.5-4.0 m thick beds in the Sherwin Formation that are laterally continuous over tens of kilometres. Several hundred million tonnes of ironstone material is present in this region. Ore quality is generally low and typically about 40% Fe, 30% SiO2 and 0.1% P, although better quality material (>50% Fe, <30% SiO2 and 0.1% P) exists in the Hodgson Downs area. Shallow drilling is required over this area to determine subsurface phosphorus levels. Thin Ordovician oolitic ironstones are present in the Amadeus and Georgina Basins.

- **Hydrothermal**: Iron-rich pods in the Frances Creek iron field (Pine Creek Orogen), Tennant Creek mineral field (Tennant Region) and Harverson Pass area (Arunta Region) are examples of this style of mineralisation. These hydrothermal iron deposits are massive, tabular to podiform, stratabound haematite/magnetite bodies formed by the enrichment of an iron-rich protolith. Hydrothermal fluids derived from magmatic or connate brines during orogenic activity have remobilised sedimentary iron in the host sequence into adjacent stratigraphic and structural trap sites. Some 8 Mt of ore grading 59% Fe has been produced from southern deposits in the Frances Creek iron field, which contains series of discontinuous, stratabound, massive haematite lenses over a 40 km strike length. Thick ore intersections (up to 110 m @ 63% Fe) are present in synclinal structures. Small resources exist in the southern (1.4 Mt @ 64% Fe and 0.08% P) and northern (2.4 Mt @ 54% Fe and 0.12% P) areas. Detailed gravity surveys over selected areas in the southern part of the field could be used to detect 1-5 Mt lenses in gently plunging synclinal structures under shallow cover.

- **Fe-skarn**: Small Fe-skarn deposits are present in the Pine Creek Orogen (Mount Bundey area) and Arunta Region. Some 840 000 t @ 63% Fe was mined from Mount Bundey between 1968-71 and a remaining resource of 190 000 t @ 62% Fe and 0.8% S exists below the pit floor (as of 2001).

- **Surficial**: Surficial iron occurrences in the NT were not considered an attractive exploration target due to their typical low tonnage and grade, although there are historical workings
within the project tenement area such as the Rumbalara Ochre Mine northeast of Finke on the margin of the Simpson Desert.

5.2. Geological Model

The description of the setting of the iron rich outcrops discovered by Tri-Star suggests that the iron mineralisation may be typical of ferricrete capping in a lateritic profile as noted by Milne et al (1985),

"Widespread weathered zones and ferricrete horizons and crusts on present highland surfaces in the region [South Australia] have been ascribed by various workers to Mesozoic or early Tertiary weathering phases. ... Ferricrete crusts sporadically distributed on the highland surfaces are interpreted dominantly as remnants of iron-impregnated sediments of ancient valleys or depressions. The great but variable thickness of kaolinized bedrock beneath the highland surfaces, regarded by other workers as the mottled and pallid zones of a 'laterite' profile, is the integrated product of leaching and weathering throughout the Mesozoic and Cainozoic ...."

An alternate model for the iron enrichment is based on the concentrations of goethite and limonite associated with iron rich shales. This is the principle concentration mechanism for the iron in bog ore typical of northern Canada and Scandinavia. Given the existence of the coal seams in the Purni Formation, there is the potential for bog iron ore accumulations at the interface between oxygenated surface waters flowing along an aquifer and the reduced iron-rich solutions percolating downwards through a swamp. At the interface ferrous iron in solution is oxidised to ferric iron which precipitates to limonite or goethite as illustrated in Figure 13. (Robb, 2005)

![Figure 13: Development of bog iron ore](Source: Robb 2005)

6. EXPLORATION

No exploration has been carried out on the property by Mining Associates Pty. Ltd. The following is a description of Tri-Star’s work programs and results.

6.1. Tri-Star Exploration

Tri-Star conducted the following work on the Pedirka Basin Project during 2009 and 2010:
- Seismic survey, February 2009: Unconventional 14 point seismic acquisition programme. The seismic programme was conducted in an attempt to follow the postulated coal seam up-dip.
- Rock chip sampling, February 2009: Surface rock chip and hand specimen sampling during the seismic acquisition programme.
- Seismic data compilation and analysis: Analysis of results from 14 point seismic acquisition programme with previous data obtained in the area (bore holes, seismic, well data).
- Geological field mapping and sampling, March 2010: additional samples were collected over EL 24900, 24901 and 24903.
- Geochemistry and petrography, May 2010: samples were submitted to a laboratory for analysis and a report was produced.
- Review of historical water bores.

6.2. Results

While following up seismic reflectance surveys that indicated the possible presence of coal beds within the Pedirka Basin, Tri-Star discovered the ironstone outcrops at the base of a series of east-northeast trending mesas in the Colson’s Pinnacle region located along the northern boundary of the tenement group (Figure 11, Figure 14). The trend includes the historical Yellow King and Yellow Queen and Rumbalara ochre mines which have not yet been sampled by Tri-Star due to weather related access problems during their field program.

Figure 14: Location of ironstone samples
(Source: Tri-Star, BMR 1:250k sheets Flinns, Hay River, McDills, Rodinge 1963-68, Google Earth 2010)
Field reconnaissance located several outcrops of ironstone at the base of hills rising out of the sand plains. Outcrops were sampled around the base of the hills (Figure 15). Samples collected from the tenements were submitted for petrological work at Weatherford Laboratories and ALS Mineralogy. Samples were also analysed for a suite of elements at ALS Laboratories in Brisbane.

Figure 15: Ironstone samples locations showing outline of interpreted iron rich horizon as defined by seismic interpretation and water bore logs
(Source: Tri-Star, Google Earth 2010)

Short seismic lines were used to map an approximate 120 by 30 km area (Figure 15) as the subsurface limits of the ironstone down-dip from the outcrops based on an interpretation of a seismic reflectance marker as an iron rich layer. This interpretation is possibly supported by nearby water bore logs which noted the following:

- "strongly ferruginous matrix" from 352'-358' (107-109m) within Crown Point Series in bore hole G53/6-113 (Bore Report RN004270)
- "ferruginous sandstone" at 401'-413' (122-126m) within De Souza Sandstone/Unit 4 in bore hole G53-117 (Bore Report RN004266)
- "ferruginous matrix" at 364'-396' (111-121m) within Crown Point Series in bore hole G53/6-122 (Bore Report RN004374)
- "hard brown rock" at 276'-277' (84-84.5m) in bore hole A24/11 (Bore Report RN007397)
Petrographic analysis by Weatherford Laboratories described the ironstones as siliceous limonites formed by replacement of clay by iron oxides. Petrographic work by ALS Mineralogy confirmed the main constituent of the ironstone was goethite associated with silicates.

Analytical work by ALS confirmed the high iron content of 8 samples collected from the ironstone outcrops.

- **Fe**: The ironstone outcrops sampled averaged 34.4% Fe with a range between 25% and 48% Fe.
- **SiO₂**: Silica content was generally high ranging from 12% SiO₂ to 56% SiO₂ with an average of 39% SiO₂.
- **P**: Phosphorous content was high averaging 0.32% P with only one sample less than 0.10% P.
- **LOI**: The water content (Loss on Ignition) of the samples was high (average of nearly 7.7% LOI) reflecting the high content of goethite-limonite in the samples.

Three (3) of the samples examined by ALS Mineralogy contained complex intergrowths of iron oxide/hydroxide with silicates which could become an issue with possible beneficiation. Only one sample of the 8 ironstones collected contained significant hematite. Sample 92 was nearly 100% goethite but the silicates recognised were fine-grained inclusions that may be difficult to separate.

Sample 92 which contained the highest iron values of the samples assayed by Tri-Star also returned the highest phosphorous, aluminium and potassium values but had the lowest silica content.

In summary the ironstones averaged 34% Fe, 39% SiO₂, 7.7% LOI, 2.1% Al₂O₃ and 0.3% P.

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Table 3: Goethite % association with other minerals in samples

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<td>93.3</td>
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<tr>
<td>43</td>
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<td>2.3</td>
<td>58.2</td>
<td>2.8</td>
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<td>0.2</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>92</td>
<td>4.5</td>
<td>5.2</td>
<td>78.1</td>
<td>11.8</td>
<td>0.0</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>101</td>
<td>3.5</td>
<td>1.5</td>
<td>91.0</td>
<td>2.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

6.3. Discussion

It is possible that the outcropping ironstones sampled are ferricrete cappings overlying kaolinitic sandstone typical of a lateritic profile and are of limited thickness and extent. MA notes that the subsurface extent of the ironstone is based on the interpretation of seismic reflectance horizon as well as water bore logs. The water bore logs record intersections of ferruginous material ranging in apparent thickness from 0.5m to 10m at depths of 85 to 125m. A limited shallow drilling program would quickly determine the validity of the seismic interpretation.

Due to the low average iron grade and the high silica and phosphorus assays, the iron stone material located to date indicates that beneficiation will be necessary to bring the material to market standards.
7. IRON ORE INDUSTRY OVERVIEW

Iron ore is one of the world’s most important mineral commodities, being used (in the form of steel) 20 times more than all other metals put together (http://www.gioa.com.au). Elemental Iron (Fe) is ranked fourth in abundance in the earth's crust and is the major constituent of the Earth's core. It rarely occurs in nature as the native metal. The pure metal is silvery white, very ductile, strongly magnetic and melts at 1528°C.

Iron accounts for approximately 95% of all metals used by modern industrial society. Metallic iron is most commonly produced from the smelting of iron ore to produce pig iron which is used for steel production. Steel is a processed form of pig iron with impurities such as silicon, phosphorus and sulphur removed and with a reduction in the carbon content.

Globally, steel's versatility is unsurpassed and due to its multiple uses in construction industries, it is directly linked to economic development and urban growth. Wrought iron (low carbon) and cast iron (pig iron) also have important markets. Historically, one of the most ubiquitous products in Australia is corrugated iron, a structural sheet steel shaped into parallel furrows and ridges used for roofing and farm buildings.

Iron metal may be produced from the smelting of certain iron compounds. Their concentration in economic proportions is referred to as 'iron ore'.

Other well known uses of iron compounds other than iron metal products are:

- iron sulphate used as fungicide, limonite, goethite, and hematite as pigments and abrasives, magnetite in the production of industrial electrodes and also for washing coal
- iron chloride and nitrate used as mordents and industrial reagents in the production of several types of inks
- iron carbonyl as a catalyst of many chemical reactions
- micaceous hematite as a protective paint on steel superstructures.

Major iron compounds

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>%Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematite</td>
<td>Fe₂O₃</td>
<td>69.9</td>
</tr>
<tr>
<td>Magnetite</td>
<td>Fe₃O₄</td>
<td>74.2</td>
</tr>
<tr>
<td>Goethite/Limonite</td>
<td>Fe₂O₃</td>
<td>~63</td>
</tr>
<tr>
<td>Siderite</td>
<td>FeCO₃</td>
<td>48.2</td>
</tr>
<tr>
<td>Chamosite</td>
<td>(Mg,Fe,Al)₆(Si,Al)₄(OH)₈</td>
<td>29.6</td>
</tr>
<tr>
<td>Pyrite</td>
<td>FeS</td>
<td>46.6</td>
</tr>
<tr>
<td>Ilmenite</td>
<td>FeTiO₃</td>
<td>36.8</td>
</tr>
</tbody>
</table>

Iron Ore Types

Iron ore is a bulk commodity. This fact drives the economics of mining projects, i.e. high infrastructure costs related to bulk transport and low units cost related to high tonnage production.

The following description of iron ore types has been sourced from South Australia’s Primary Industries and Resources SA ("PIRSA") website.
The major iron ore rock types are:

- 'high-grade' ore:
  - massive hematite, and
  - pisolitic goethite/limonite;
- 'low-grade' ore:
  - banded metasedimentary ironstone,
  - magnetite-rich metasomatite,
  - less commonly, siderite-rich and chamosite-rich ores

**High-grade ore**

Currently most of the iron ore mined in the world comes from large deposits of massive hematite rock formed by the in situ enrichment of a protore already enriched in iron, most commonly a banded iron formation ("BIF").

Two of the best known Australian examples of massive hematite deposits are Tom Price and Mount Whaleback in the Hamersley Range, Western Australia. Another type of high-grade deposit is pisolitic limonite/goethite ore formed in ancient river channels, e.g. Yandicoogina, Hamersley Basin, Western Australia.

The consensus model for formation of massive hematite ore is enrichment by the passage of fluids, which remove the non-iron-bearing minerals (dominantly chert), and to a much lesser extent adds iron minerals. There are several variants of this model with the most accepted being enrichment by supergene processes. Recent models suggest enrichment by mass lateral and upward migration of dominantly superheated meteoric waters perhaps with a minor magmatic component.

High-grade ore generally has a cut off grade of ~60% Fe. Historically it has provided a direct feed to smelters either as raw lump or fines, and also in a processed form such as sinter or pellets. There are emerging markets for new varieties of feedstock. Examples include sintered iron carbide and 'DRI' ore (direct reduced iron), which is natural ore with Fe >69% and low levels of specific trace elements suitable as feed to 'direct reduction' smelters.

**Low-grade ore**

Low-grade ore is a term applied to iron-rich rocks with cut-off grades in the range of 25–30% Fe. It was the main supply of iron ore for many centuries during the world's early history of production of iron. Since the 1950s North America's main supply source has been low-grade ore.

The dominant economic iron mineral in low-grade ore is magnetite. The ore may be easily beneficiated by a process know as wet-magnetic separation - this process has been employed for many decades in North America.

BIF with hematite as the dominant iron mineral may also be beneficiated through wet hydrometallurgical processes though it rarely done due to economic constraints.

**World production and resources**

Current world production of iron ore is dominated by supply from massive hematite deposits.

World resources of crude iron ore are estimated to exceed 800 billion tonnes containing more than 230 billion tonnes of iron. The world's resources are dominated by low-grade ore, the most
significant of which are BIF preserved in the remnants of Palaeoproterozoic sedimentary basins. Examples include BIF in the:

- Hamersley Basin in Western Australia
- Lake Superior Region in North America
- Transvaal Region in South Africa
- Krivoy Rog Region in the Ukraine
- Minas Gerais Region in Brazil.

Iron oxides of metasomatic origin also form a significant resource. The best example is the Kiruna deposit in Sweden which is the world's largest mine developed on a low-grade, magnetite-rich metasomatite rock.

**Australian Iron Ore Industry**

In 2008, economic demonstrated iron resources ("EDR") of Australia were 24 gigatonne (Gt) of which Western Australia contributes 98% with about 86% occurring in the Pilbara district. Magnetite ore currently constitutes 24% or 5.7 Gt of Australia's EDR. Ore production in Australia is dominantly from high-grade hematite and pisolithic goethite-limonite deposits, mostly in the Hamersley Basin region in the Pilbara district of Western Australia.

The bulk of Western Australia's iron ore industry is centred on operations in the Pilbara where two of the world's richest iron ore deposits are located – Tom Price (owned by Rio Tinto) and Mount Whaleback (owned by BHP Billiton).

The Pilbara accounts for approximately 95% of Australia's total current iron ore production, with the remainder primarily coming from other areas within Western Australia. Minor production also comes from Tasmania, New South Wales, Queensland and South Australia.

The Australian Bureau of Agricultural and Resource Economics ("ABARE") reported that Australia's iron ore production in 2008 was 341.1 Mt with 97% produced in WA. Exports in 2008 totalled 310.2 Mt with a value of $30.6 billion. They have projected that Australia's iron ore production will increase some 55% from 324.7 Mt in 2007-08 to 504.9 Mt in 2013-14. Exports are projected to rise 61% from 294.3 Mt to 473.5 Mt over the same period (Geoscience Australia, 2009).

**7.1. Barriers to entry**

Iron ore is a bulk commodity. This fact drives the economics of mining projects, i.e. high infrastructure costs related to bulk transport and low unit cost related to high tonnage mining output. The viability of an iron ore mining development therefore is constrained by location (i.e. location relative to transport infrastructure) and cost of mining, processing and re-handling.
7.1.1. Location

Rail and port infrastructure is essential in transporting high volumes of iron ore to overseas customers. In terms of location, the following points illustrate the best case scenario for the location of an iron ore deposit (Flis, 2010):

- Access to existing, available, open-user rail
- Access to existing, available, open user port
- Occurs in an infrastructure-rich area
- Low environmental, native title & social risks

The high costs of shipping infrastructure has led to the formation of two alliances among Western Australian junior iron ore companies in order to establish shared infrastructure in their districts: The Northwest Iron Ore Alliance for development of infrastructure in the Pilbara, and the Geraldton Iron Ore Alliance for developments in the mid-western region.

7.1.2. Iron Ore Quality Requirements: Grade and Deleterious Elements

For an iron deposit to be mined economically, the iron content must be greater than 55% for direct shipping ore (“DSO”) but can be as low as 30% if the iron oxides are amenable to concentration (“beneficiation”) to a higher iron content (“BSO”). In addition, the material produced must be low in manganese and other deleterious elements such as silica, aluminium, phosphorus, sulphur and alkalis.

The generally accepted maximum content ranges for deleterious elements are listed in Table 4.

<table>
<thead>
<tr>
<th>Element</th>
<th>Maximum for DSO or BSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al₂O₃</td>
<td>3.50%</td>
</tr>
<tr>
<td>SiO₂</td>
<td>3.50%-5.0%</td>
</tr>
<tr>
<td>P</td>
<td>0.05%</td>
</tr>
<tr>
<td>S</td>
<td>0.03%</td>
</tr>
</tbody>
</table>

Source: Platts 2010

To offset the higher costs associated with beneficiation, lower grade ores need to have low mining costs (i.e. be open pittable) and be minable by bulk methods with ore zones easily segregated from other interbedded rock types.

One of the main deleterious elements in iron ore is phosphorus which is either incorporated into the crystal lattice of iron oxides or into the gangue minerals. During high temperature reduction of iron ore phosphorus content can be further concentrated. This element has a negative impact on the workability of steel and for this reason most processors prefer low-P ore (less that 0.08 wt% P) and therefore many high-P iron ores are not exploited (Delvasto, et al, 2007)

7.1.3. Beneficiation

There are basically 2 reasons for beneficiation: increasing iron content and reducing deleterious elements content. Costs increase with the level or degree of beneficiation as do handling costs.
Simple crushing and screening is commonly carried out on hematite/goethite ore which is suitable for DSO (>55% Fe). This simple treatment can both increase iron ore grade and decrease silica and alumina content.

For magnetite ore which is usually lower grade, beneficiation uses magnetic separation after fine grinding to increase the iron content to marketable grades. This method produces an ultrafines product requiring agglomeration or pelletising.

For low grade iron ore (i.e. goethite), beneficiation involves heating to drive off the water content. This is done by calcination at 1400°C which removes the volatiles (H₂O and CO₂) to produce a market iron grade calcined iron (CaFe) as outlined in Figure 16.

![Beneficiation method for goethite](Source: after Young, 2009)

**7.2. Beneficiation of Pedirka Iron Oxides**

The main deleterious elements assayed from the iron oxide samples collected by Tri-Star were phosphorus and silica (Table 5) and to a lesser extent, Al₂O₃ and S.

<table>
<thead>
<tr>
<th>SAMPLE NO</th>
<th>Fe</th>
<th>SiO₂</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>01</td>
<td>25.1</td>
<td>56.4</td>
<td>0.33</td>
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<tr>
<td>02</td>
<td>30.2</td>
<td>46.9</td>
<td>0.35</td>
</tr>
<tr>
<td>07</td>
<td>36.0</td>
<td>36.1</td>
<td>0.56</td>
</tr>
<tr>
<td>21</td>
<td>25.4</td>
<td>51.7</td>
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<td>41</td>
<td>36.5</td>
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</tr>
<tr>
<td>43</td>
<td>42.7</td>
<td>27.6</td>
<td>0.08</td>
</tr>
<tr>
<td>92</td>
<td>48.1</td>
<td>12.3</td>
<td>0.59</td>
</tr>
<tr>
<td>101</td>
<td>31.0</td>
<td>46</td>
<td>0.29</td>
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<td>Average</td>
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<tr>
<td>Maximum</td>
<td>48.1</td>
<td>56.4</td>
<td>0.59</td>
</tr>
<tr>
<td>Minimum</td>
<td>25.1</td>
<td>12.3</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Phosphorus Content

As noted above, the phosphorus content in the samples collected to date is high relative to DSO, and it would be necessary to lower the P content through beneficiation methods. There are examples in Australia of high P iron ore being beneficiated, e.g. Razorback Ridge in South Australia, a bedded magnetite with a high 0.44% P content reduced to 0.01% through beneficiation to a concentrate at 106μm (Figure 17).

![Table showing Phosphorus Content](source: Fig. 2010)

Phosphorus in steel increases hardness, strength, fluidity, and brittleness and reduces the melting point and carbon solubility. It is generally accepted that phosphorus is an unwanted contaminant in iron ore because it makes steel brittle. Phosphorous mineralogy is dependant on the nature of the host rock. In magnetite deposits, phosphorous often occur as discrete phosphate minerals (such as apatite) that can be removed during the beneficiation and concentration of magnetite. In hematite/goethite Banded Iron Formation (BIF) phosphorous tends to be dispersed and is often incorporated within the goethite lattice. This may be the case with the Pedirka samples. Incorporation into the lattice of a major iron containing unit makes it difficult to separate using conventional beneficiation processes.

According to the CSIRO, there is 8 billion tonnes of known high phosphorous (>0.10 wt% P) BIFs close to existing infrastructure and no known economic process for reducing levels of phosphorous. According to Cheng et al (1999) more than 80% of Western Australian iron ore contains an average of 0.15% phosphorus, and attracts a penalty due to its high level of phosphorus when exported. At the current rate of mining, identified premium grade iron ore with low phosphorus content (<0.05%), Cheng et al estimated will be depleted in 30 years. The development of an economical dephosphorisation process is considered critical for the future success of the Western Australian iron ore industry.

The samples collected by Tri-Star are goethite rich with relative high P content (Table 3). Goethite is reported to occur as a ubiquitous phase in many iron ore types. It was noted in a study of goethite rich ore from the Bonai–Keonjhar Belt in Orissa, India that goethite replacing hematite is generally devoid of deleterious elements while re-precipitated goethite generally contains adsorbed alumina, silica and/or phosphorus. Nodular goethite commonly has a high phosphorus level while botryoidal, spheroidal and platy goethite often contain increased combined alumina and silica. Goethite having a reniform, wedge, intergranular or intragranular microstructure is highly water bearing and cryptocrystalline in nature. During dehydration, bead, comb, cavity-lined or prismatic goethite develop, which are more crystalline and which have a higher iron concentration. Goethite with a wedge, prismatic or bead-type microstructure has a higher adsorption of silica (2–4%), while goethite having an intergranular, bead or prismatic microstructure invariably contains appreciable phosphorus, generally at levels deleterious to processing (Mohapatra, BK et al, 2008)
Phosphorus can be removed from iron ores by either physical or chemical means depending upon the degree of association of phosphorus with the minerals in the ore. Physical methods generally use comminution followed by wet magnetic separation while froth flotation is generally employed when the phosphatic gangue minerals appear as discrete inclusions in the iron oxide matrix. When the P is disseminated in the iron oxide structure, possibly forming cryptocrystalline phosphates or forming solid solutions with the Fe-oxide phases, beneficiation can only be accomplished by chemical methods (such as roasting and leaching). Biological dephosphorisation has also been studied (Delvasto et al, 2007).

**CSIRO Beneficiation Technique (Lovel, 2010):** CSIRO is testing a low temperature “heat and leach” phosphorous removal process. This research spans characterisation to flotation with biological floatation agents. The process uses low temperature thermal treatment to transform goethite into hematite. This transformation results in a recrystallisation of the iron oxides and dehydroxylation (i.e. a loss of water). The transformations also make some of the phosphates more readily available for leaching. A 350 °C thermal treatment combined with a 25% pulp density leach has been sufficient to reduce phosphorous levels from around 0.13% to below 0.08% in some ores.

In laboratory tests, the low temperature heat and leach process can typically remove 30 and 50 wt % of the phosphorous. The level of reduction is enhanced by increasing the level of transformation of goethite to hematite (i.e. increasing the thermal treatment temperature or time at temperature), increasing the concentration or temperature of leachant, increasing the leaching time and reducing the pulp density in the leach system. Lovel’s team evaluated the process on 5 ores and results suggest that the phosphorous is more easily reduced in some ores than others.

**Dephosphorisation hydrometallurgical process:** Cheng et al (1999) demonstrated effective dephosphorisation of Western Australian iron using sulphuric acid as the leachant on the basis of its availability and low cost. The iron ore sample used in this study typically contained 0.126% phosphorus and was from the Pilbara region of Western Australia. After roasting at 1250°C lump ore P80 5.6 mm), pellet 1 (grinding to 100% -1.5 mm before pelletisation) and pellet 2 (grinding to 100% -0.15 mm before pelletisation) were leached in solutions with different sulphuric acid concentrations. After leaching for 5 hours at 60°C in 0.1 M sulphuric acid solution, 67.2%, 69.0% and 68.7% of the phosphorus was leached from the above three samples, respectively. The phosphorus content was reduced from 0.126% to 0.044%, 0.055% and 0.042% respectively. The dissolution of iron during leaching was negligible. The optimum sulphuric acid concentration was 0.1 M in terms of acid cost and iron loss. The acid consumption cost is as low as $A 0.47/tonne.

**Silica Content**

As noted in the ALS analysis report, the association data for goethite indicates the mineral is predominantly associated with silicates (Table 3). ALS noted that Samples 2, 7, & 21 contained very complex intergrowths of Fe oxides/oxides/hydroxides with silicates and that this may have implications for upgrading of the deposit. Sample 92 has a very high content of goethite but the silicates that were detected were fine grained inclusions that ALS considered would be very difficult to separate from the main Fe bearing minerals.
At present, the usual method for lowering SiO₂ content is through comminution with the liberation of silica (i.e. quartz particles) increasing with finer grinding and washing.

MA notes that the majority of samples have associated quartz particles with the exception of sample 92 which has quartz particles plus 11.8% “other silicates”, i.e. silica intergrowths. In this case, upgrading material with silica intergrowths is a more difficult and complex process.

Several advanced technologies have been developed to improve the separation of finer materials including silica. Beneficiation is possible under dynamic conditions and/or in multistage processes. Dynamic separators can achieve sharp separation, but they are usually complex and expensive to maintain because of moving parts. Multistage processes are energy intensive and difficult to operate and control. Flotation to reduce silica content has now become an established technique in the Indian iron ore industry (MaxFlot, 2010).

7.3. Iron Ore Industry Outlook

According to the Financial Times (Blas et al, 2010), iron ore is the world’s second-largest commodity market by value after crude oil, and is central to the world’s economy. It forms part of the production process of almost anything that requires steel: ships, buildings, refrigerators, cars. Steel represents almost 95% of the total metal that is used globally each year making iron ore more integral to the global economy than any other raw mineral material.

Since the mid 1990s China has emerged as the main consumer in the iron ore market replacing the traditional key imported of Japan and South Korea.

![Table: Global Iron Ore Market 2004](Source: Blas et al. 2010)

AME Mineral Economics (2010) see China as the key driver of the global iron ore industry for the foreseeable future. They believe that Chinese iron ore demand is primarily driven by GDP growth, which considerably exceeds Western World growth rates, contributing to its rapid industrialization and urbanization on a huge scale. BHP notes that steel intensity per capital grows strongly as nations become wealthier, and Figure 19 highlights China’s current low position on the growth curve, supporting AME’s position.
Australia is the largest supplier of iron ore (Figure 18). Iron ore sales for Australia are expected to continue to significantly increase over the next decade, underpinned by the ongoing strength of the Chinese, South Korean and Taiwanese steel industries, as well as continued strong demand from Japan. The CSIRO report indicated that demand for Australian iron ore could rise by more than 200 million tonnes a year over the next few years.

The Australian Bureau of Agricultural and Resource Economics (“ABARE”) is predicting a positive outlook for the global steel industry in 2010-11, which will drive iron ore exports up to $35.1 billion. ABARE forecast steel consumption would grow rapidly by 8% to 1.3 billion tonnes in 2010-11, thanks to continued industrialisation in developing economies. This follows a 9% decline in steel consumption in 2009-10. Furthermore, steel consumption is projected to grow by an average of 6% each year to reach 1.8 billion tonnes by 2015. ABARE have also projected that Australia’s iron ore production will increase to 504.9 Mt in 2013-14. (Geoscience Australia, 2009)

"As the world's largest exporter of iron ore and metallurgical coal, increased import demand will underpin significant increases in Australia’s exports of steel-making raw materials over the medium term," the Bureau said (Mills, 2010).

Rio Tinto’s CEO, Tom Albanese was quoted stating "Over the next 15 years we expect consumption trends to lead to a doubling in demand for iron ore, aluminium and copper. We also expect substantial increased demand for energy. These trends will require a significant response from producers... Let me put this in perspective. By 2030 the additional supply required will be equivalent to replicating the iron ore output of the Pilbara region of Australia every five years, adding another aluminium production complex the size of Canada’s Saguenay every nine months, and developing another copper mine the size of Escondida in Chile each year...The long term outlook remains very strong and we are now ramping up our growth projects." (Fitzgerald, 2010)

Australia’s projected increase in iron ore exports is illustrated in Figure 20.
In terms of pricing, iron ore pricing changed in March 2010 from annual negotiation system to a market pricing system based more on quarterly spot prices.

"Since the 1960s representatives of the world’s largest mining companies have held secretive negotiations to set prices for contracts with the big steel producers. Traditionally, the first deal between a miner and a major steelmaker set a “benchmark” which was followed by the rest of the industry, from Japan and South Korea to China and Germany.

During the past year (2009) this pricing system has been challenged after China, the world’s largest importer of the commodity, refused to accept a “benchmark” deal between the miners and Japan, opting instead to buy in the spot market. This failure is a threat to the 40-year-old traditional system and has boosted the importance of the spot market and hybrid contracts.”

(Blas et al, 2010)

This change is reflected in the historical and forecast price charts (Figure 21, Figure 22)
8. CONCLUSIONS & RECOMMENDATIONS

In MA’s opinion, a substantial deposit would need to exist to justify the high costs of development and ore transport, due to the remoteness of the region, the lack of existing infrastructure and the requirement for ore beneficiation.

The average iron ore grade from all samples is less than 40% although the highest grade of 48% is encouraging. The samples have high silica and relatively high phosphorus assays indicating that beneficiation will be necessary to bring the material to current market standards.

If an iron ore resource of sufficient size were to be outlined, MA would suggest that there are a number of aspects which would be positive for the future development of the resource:

- It is possible with the on-going work by CSIRO that in the future, beneficiation for removal of phosphorus content will become an economically viable process.
- Any processing of ore would be assisted by the discovery of minable coal (which is know to occur in the Pedirka Basin) providing a potential energy source for iron ore beneficiation and access to shared infrastructure.
- In terms of location, although the Pedirka project area is remote, it is only 150km due east of the Darwin to Adelaide rail link, a transcontinental transport route stretching from the north to the south of Australia.
- There have been discussions of an alliance among iron ore juniors working on the Eyre Peninsula, South Australia for developing or expanding deep water facility port access; such an alliance would be positive for the Pedirka project.

The current market view is for long term (+10 years) continued growth in global iron ore demand due to the escalating global modernisation particularly in China. Given this growth outlook, any substantial iron ore discovery in the Pedirka Project area has the potential to be upgraded to iron ore reserves in the future.
MA recommends the following activities as part of Tri-Star’s on-going exploration to increase the knowledge base of the Pedirka iron mineralisation:

- A shallow drilling program would quickly determine
  - the validity of the seismic interpretation
  - the validity of the water bore log descriptions
  - the thickness and potential areal extent of the iron rich unit
  - the grade and mineralogy of the mineralisation
  - the lateral variations in quality and thickness.
- Detailed sampling and geological mapping of the ironstone outcropping areas including the Rumbalara ochre deposits.
- Metallurgical study of surface and subsurface ironstone material to determine beneficiation requirements.

An additional drilling target would be the Purni coal sequence which has been previously intersected in drilling by petroleum explorers elsewhere in the Pedirka Basin.

It is MA’s opinion that the characteristics of the iron-rich samples collected to date within Tri-Star’s Pedirka Basic Project area suggest that an eventual resource project will require significant beneficiation including:

1. Reduction of phosphorus;
2. Reduction of silica and other deleterious elements
3. Increase iron content by removal of water and volatiles.

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South Australia’s Primary Industries and Resources SA

