The Southern African Meteorite Recovery Program

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Abstract. The Southern African Meteorite Recovery Program is another example of how amateurs can aid professionals. The Program operates under the auspices of the Johannesburg Centre of ASSA in association with the University of the Witwatersrand and the South African Heritage Resources Agency.

1. Introduction

Meteoritics in South Africa is governed by the National Heritage Resources Act Number 25 of 1999. The Program results from the 62nd Annual Meeting of the International Meteoritical Society, which was held in Johannesburg in 1999.

2. Scope of the program

2.1 Search for historic falls

(a) Cold recovery or search for historic falls. The Program operates twice annual expeditions to desert environments in South Africa to test equivalent environments to those that have proved to be successful meteorite hunting grounds elsewhere in the world.

(b) Search in institutional collections and the literature for meteorites unrecorded in the database.

2.2 Southern African Meteorite Database

Progress is being made in providing a single electronic database of all falls and finds in South Africa, with equivalent data for Namibia and Lesotho. To date, 50 meteorites are found in the South African database, 19 in the Namibian database and the first entry in the Lesotho database resulted from a fireball that fell on Sunday 2002 July 21.

The intention is to provide a wide variety of data for each entry, including references to papers written, the location of individual samples, as well as images [*A subset of the data is available as a Microsoft Excel file from the author – Ed.*]

The Database is still in progress, and it is noted that the record of South African meteorites is incomplete – a search of museums, institutions and the literature is likely to uncover more meteorites than a cold search. A number of meteorites in museums have never been studied.

2.3 Curation and security

It has been demonstrated that in common with much of the world, methods of curating meteorite collections in museums and institutions fall well short of that desirable to ensure the collections long term well-being.

Examples include the instances of theft of meteorites from South African museums, the instances of mis-labelling, and the lack of a channel to ensure that a condition of entry of a meteorite into a collection is analysis by a competent meteoriticist.

This aspect requires the design and implementation of an internationally acceptable standard for meteorite collections, which is also cost-effective.

2.4 Updating and revision of legislation [Act 25 of 1999]

Current legislation fails to achieve the aims of planetary scientists in South Africa and requires extensive revision.

The aims of science are to encourage potential finds/falls to be handed in for analysis and to prevent the illegal export of meteorites.

The intention is to employ international best practice so that the revised law can act as a model to the international community.

A straw man illustrating a method to achieve this has been provided. Once consensus is achieved, the Program will assist in drafting the revision and in lobbying the powers that be to effect the change (Annexure 1 overleaf).

2.5 Project to increase awareness of planetary sciences in SA

By means of informal talks and articles, and in conjunction with other efforts, it is hoped both to raise an awareness of planetary sciences in South Africa and volunteers to participate in aspects of the Program.

2.6 Develop a country-wide co-ordination process for hand-ins and follow-up of falls

It is important to have a central channel through which bright fireballs can be reported. Tim Cooper has demonstrated the value of this approach.

Many people report the discovery of apparent meteorites, which are unsupported by fireball data, and this is the aspect that needs to be formalised. It is again hoped that sufficient regional volunteers can be found who will be prepared to act as regional co-ordinators for such reports.

Another aspect of this is to investigate the concept of using meteor scatter to record bright non predictable fireballs using at least a trio of radio receivers that recode time and signal strength, with input to software which can automatically triangulate a search area, and e-mail the output to participants.

2.7 Automation of fireball data and triangulation of potential fall sites

It is planned eventually to employ the ionisation of the atmosphere by incoming meteors (meteor scatter) to provide automation of fall data.

The plan calls for a transmitter to bounce a broadcast signal off the meteor scatter layer to be received by at least three widely separated receivers. The signal strength will be recorded, and the recordings input to software, still to be written, which will extract the strongest signals excluding those from predictable falls, which do not produce meteorites. The software will compare signal strengths from each of the receivers and triangulate a potential fall area. This will trigger an e-mail to participants to investigate that area.

As experience increases, so the software can be refined until it becomes a meaningful tool for recoveries.

As volunteers subscribe to the Program, so people can be assigned to search their own areas.

Annexure 1: A simple proposal to update legislation as it relates to Meteorites in South Africa

1. Source

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2. Existing problems

The existing legislation is essentially unenforceable, owing to the difficulty of identifying meteorites outside of a well equipped laboratory.

The concept of promoting public awareness of planetary sciences is at odds with the requirement that only persons in possession of a valid permit may retrieve a meteorite.

Legislation relating meteorites is bundled together with heritage objects, archeaological artefacts, fossils and shipwrecks. This assorted mish-mash does not lend itself to promote the objectives of meteoritics.

The new law is said to have been the result of consensus amongst interested parties, but none of the practicing researchers in South Africa were consulted.

3. Influences

The following external influences are noted: effectiveness of enforcement; illegal trade; 'heritage' requirements & scientific requirements (meteoritics).

4. Differentiation of meteorites from other objects contemplated in National Resources Act 25 of 1999

A set of reasons is listed below as to why meteorites should be differentiated from existing objects in the legislation:

1) Meteorites are far rarer than palaeontological or archaeological objects;
2) Meteorites weather extremely rapidly and there is a need for speed in the recovery stage;
3) Awareness of planetary sciences needs to be encouraged, not stringently regulated;
4) Objects that weather to unrecognisable rocks within a year are not heritage objects;
5) South African museums have not displayed an ability to care for meteorites in their possession - they are either stolen, or housed in ill-considered places.

5. Recommendation

The remainder of this note attempts to address the problems and produces a draft proposal to update the law that is both practical and designed to achieve the objectives of meteoritics in South Africa. It is hoped that all interested parties will improve/delete/change/alter the contents until concensus is reached.

6. Legal scope

1) Separation of legal matters relating to meteorites and meteoritic material from the materials and objects covered in the National Heritage Resources Act Number 25 of 1999.
2) Scope limited to Meteorites originally discovered in South Africa or such territories as may have been under the control of South Africa at the time of discovery.
3) Meteorites and/or fragments with a mass of less than 1 gram are excluded from the legislation.

[Item 2 means uncontrolled trade in non-South African meteorites. Item 3 prevents my being locked up for emptying my rain gauge (micrometeorites), and may also ease operations with thin sections.]

7. Process

1) On discovery, notify your local authority. The local authority may be any one or all of: a museum, the Geology Department of a University, the Council for Geosciences; the Geological Society of South Africa.
2) The local authority will notify a Central Authority;
3) A telephone 'hotline' will be available for notification purposes;
4) A formal recovery operation is mounted [guidelines];
5) The recovered object is submitted to one or more practicing researchers in meteoritics for analysis;
6) If it proves *not* to be a meteorite the discoverer and reporting local authority is notified;
7) If it proves to be a meteorite, the analyst notifies the Central Authority.
8) Central Authority updates the South African Meteorite Database; notifies the local authority and the finder as well as the Press [part of the Awareness Campaign];
9) At the discretion of the relevant Authority, the finder may be offered either a realistic [perhaps market] value for the meteorite, in which case the meteorite now belongs to the Authority. Alternatively, the finder may be offered a certificate of Analysis, in which case the meteorite belongs to the finder and may be transacted accordingly.
10) Both the Certificate and offer of reasonable value encourage reporting of finds.

8. Implementation

The requirement for upholding the proposed legislation is de-skilled to asking the question "If this is a South African meteorite, do you have a Certificate of Analysis for it?" The penalties for contravention are not the subject of this note.

9. Awareness

The Central Authority will provide funds to conduct an awareness campaign at museums and educational institutions.

10. Funding

Attention is drawn to the practice in New Zealand and Australia, where a tiny portion of the proceeds of the National Lottery are set aside to promote the activities of amateur astronomers.

Prof Brian Warner of UCT vets applications from interested amateurs and recommends whether or not funding should be provided for individual amateur projects.

A similar method could be applied in South Africa to fund the acquisition of meteorites by the State Authority, as well as fund amateur scientific equipment needs.

11. Benefits

The method encourages the reporting of finds, reducing the risk of meteorites leaving the country illegally without initial scientific analysis.

Trade in meteorites will continue, but on a sound legal footing. South African meteorites can only be traded by someone in possession of a Certificate of Analysis.

The Certificate of Analysis will serve to raise the value of the meteorite for trade purposes.

Existing traders/collectors of meteorites will co-operate with the authorities.

Private collections of South African meteorites will become legal [and will already exist in the database].

Control will be in the hands of the proper authorities.

Annexure 2: Cold Recovery Results

Phase 1 of the cold recovery program has been completed, but no meteorites were found. Phase 2 will use a different, but proven, search criterium, in entirely different geomorphologies. Details of the Phase 1 search findings follow.

Toward a South Africa specific geomorphological approach to systematic meteorite recovery

1. Summary

Active meteorite recovery has not previously been done in South Africa and therefore it was decided to make use of approaches that work in other parts of the world, namely, the South Western U.S.A. and Western Australia.

While to date, no meteorites have been recovered, they are out there, and future recovery expeditions are likely to meet with success.

2. The Scale of SA expeditions.

Expeditions are small in number and consist of amateurs sourced under the auspices of the Johannesburg Centre of ASSA. Two Expeditions are conducted annually. Expeditions are conducted on foot for a few days at a time.

As a result, the low volume search effort has covered only a tiny fraction of the potentially favourable search areas.

An example of man-distances to be covered to find one meteorite: Given a square 10 km on a side, with the certainty of having one definite, recognisable meteorite in it, and given a search methodology calling for each participant to search 2.5 m to the left and 2.5 m to the right, 2 000 traverses are needed, each 10 km long. The search distance maximum would involve 20 000 km of walking. Statistics vary and are at best a guide: for North Africa, the expectation is one meteorite per 200 km^2.

3. Standard geomorphologies that have proved successful elsewhere

Playa lakes: In the United States meteorite searches have been successfully conducted on playa lake surfaces, even on motorcycles. In fact, dark meteorites on light surfaces can be found using binoculars. Playa lakes remain dry all year round and for long periods of time.

Arid terrains: Arid terrain lends itself to meteorite recovery, as the lack of vegetation improves visibility. Additionally, arid terrains slow the weathering of meteorites, which for chondrites falling in a higher rainfall area, could become unrecognisable within 12 months.

Contrast: Successful meteorite recovery relies heavily on contrast between light coloured surfaces / rocks and dark meteorites.

Geomorphologically ancient surfaces: The older, and more stable a surface is geomorphologically, the more meteorite strikes it will have sustained, and the higher the potential recovery.

Desert dunes: Theoretically, dunes should soak up meteorite falls, and deposit them gently on the erg surface as they move on. This assumes that the dunes are mobile, and that there is insufficient sand to cover the desert pavement completely. Searches are therefore conducted in the inter-dune pavement areas.

4. The South African Experience

4.1 Lack of detailed geological maps

We headed for a site that was marked 'Pietermaritzburg Shales' and discovered extensive surface fragments of BIFs, lavas, etc.

4.2 Playa Lakes

ENSO

The El Nino Southern Oscillation has played a role in non-recoveries: The playa lakes in South Africa, 'pans', are subject to occasional regional rainfalls, associated with the ENSO. In many cases, the pan surface is covered with water for a period of months. Any meteorites that may have fallen on the pan sink in the mud or become covered with mud, rendering them unrecognisable.

Danielskuil

A pilot project was conducted at Danielskuil, a large pan surface. To our surprise, much of the pan surface was covered in short grass, and the pan had been under water twice in a decade. Bare areas were light in colour and there were a large number of dark rocks on the surface. Unfortunately, these all turned out to be Transvaal Dolomite from the underlying facies. The expected conditions were less favourable than expected and the signal to noise ratio was lower than expected.

Verneukpan

The first full expedition headed further West on the grounds that western parts of Southern continents are dryer, more arid and have less vegetation. We headed for Verneukpan, which unfortunately, was under water, as a result of widespread regional rains, with 38mm recorded in the vicinity two days before arrival. We were unable to reach Verneukpan.

Six months later, we called in on Verneukpan, only to find parts still under water, and much of the rest covered with a layer of new mud and sand.

To summarise the South African experience of meteorite recovery on playa lakes, we now think that playa lakes may be useful for recovering fresh falls and useless as a repository of historical falls.

4.3 Palaeo-Dunes

Vaalputs

The Easter 2001 Expedition was conducted at Vaalputs National Nuclear Waste Dispos-

Verneukpan

The Easter 2001 Expedition to the Vaalputs National Nuclear Waste Disposal site.

al site. The area searched was divided into two distinct terrains: (1) a palaeodune area covered in discrete vegetation, and (2) an eroded rocky area of granite gneiss.

Biological turnover

Our experience there illustrated the extent of soil turnover on the palaeodune area as a result of bioturbation. Plants, insects, and animals dug into the soil and refreshed the surface layers, resulting an apparently old geological surface showing an actual fresh face.

The eroded gneissic area had small areas of coarse sand associated with run-off. Dry stream beds were searched in hope that they may prove to be serendipitous concentration mechanisms. We came across many pieces of dark, metallic and magnetic material, radioactive in beta and gamma, but not in alpha, that proved to be crystalline haematite, common in the area and also toward Garies.

The South African experience of palaeodune geomorphology is that the potential for meteorite recovery is degraded by biological turnover.

4.4 Ancient Deflated Surfaces

Kenhardt District

The Spring 2000 Expedition focussed on ancient geomorphological surfaces to the west of Kenhardt. These surfaces presented alternating grassy and bare areas and searches were confined to the bare areas. The bare areas showed evidence of recent run-off and run-offs were searched as well.

Once again, unexpected noise from ubiquitous BIF remnants resulted in a fine collection of magnetic banded ironstone meteor-wrongs.

The SA experience here is one of a reduced signal to noise ratio caused by these BIF remnants.

4.5 Desert Dunes

A number of Expeditions searched inter-dune pavement areas to the North of Upington, and South of the Kalahari Gemsbok National Park.

It was expected that dune migration over a long period of time would expose meteorite falls in the inter-dune areas. The dunes are permanent dunes oriented parallel to the prevailing wind direction.

The South African experience is that the inter-dune areas of the Kalahari are also covered in a deep layer of sand, which covers any falls, and, worse, is itself covered by fairly thick vegetation.

The Recovery Program intends to operate further phases, including the fielding of notification of possible meteorites by the public. It is expected, and this has also been our experience, that many things are mistaken for meteorites, including space junk.

The potential for recovery of real meteorites from this source is limited, but the exercise will enhance awareness amongst the public of meteoritics.