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**Review: Geological/geomorphological
aspects of the Wilderness Society's
September 1992 proposal for a World
Heritage Area in the North West Forests**

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Review: Geological/geomorphological aspects of the Wilderness Society's September 1992 proposal for a World Heritage Area in the North West Forests

SUMMARY AND CONCLUSIONS

1. Along with many botanical and zoological features, the Wilderness Society's proposal cites a number of geological/geomorphological features which are identified as having World Heritage Value according to one or more of three criteria (Appendix 1, 5b). The criteria and features are as follows.

Criterion 1:

Outstanding examples representing the major stages of the Earth's evolutionary history.

Features

- (a) Regional geology of the entire area.
- (b) Marine-cut coastal benches.

Criterion 2:

Outstanding examples representing significant ongoing geological processes, etc.

Features

- (a) Karst phenomena in rock formations consisting mainly of the mineral magnesite ($MgCO_3$).
- (b) Joint-controlled drainage on the Meredith Range.
- (c) Fold structure control on geomorphology.

Criterion 3:

Superlative natural phenomena, formations or features, etc.

Features

- (a) Meredith Range granite landscape.
- (b) Sandy Cape and Lagoon landscapes.
- (c) Karst in magnesite.
- (d) Joint-controlled drainage on the Meredith Range.
- (e) Sandy Cape dunefields.

2. Although the proposal and its principal source reference (Harries, 1992) provide considerable scientific documentation of the geological/ geomorphological features identified, the proposal **does not demonstrate** that the features are of World Heritage value. Specifically, it does not address the issue of providing convincing comparative evidence that the features are either outstanding or superlative.

3. Of the geological/geomorphological features identified, two are assigned particular importance by being included in the list of fourteen World Heritage Values given in the Executive Summary. These two features are:

- (a) Karst in magnesite (p.ii, p.9, p.30, p.38, p.45), for which global rarity is claimed and global uniqueness implied. However, karst in magnesite is **not unique** to the North West Forests. Instead, the readily accessible literature demonstrates that karst in magnesite is present on at least three other continents. It is likely that karst phenomena are developed wherever magnesite occurs as a rock formation.
- (b) Joint-controlled drainage (p.iii, p.8, p.40, p.41, p.44, p.45), which is developed on the Meredith Range. This drainage is identified as an outstanding example and superlative phenomenon under Criteria 2 and 3 respectively **but no substantiating comparative data are given**. Comparisons with drainage patterns described in the literature show that the Meredith Range drainage is representative of the class of stream patterns known as rectangular or, more strictly, angulate. The Meredith Range pattern does not appear to be either outstanding or superlative like, for example, the Ruined City in Arnhem Land (Hills, 1963).

4. In the Juridical section of the proposal the authors do not acknowledge rights possessed by prospectors and miners under regulations which currently apply in the North West Forests. Action which is expected to be taken in respect of these rights if the proposal goes ahead should be outlined in the proposal. The matters of substantial financial loss and probable costly compensation claims in respect of existing Mining Leases and Retention Licences are unstated.

INTRODUCTION

In September 1992 The Wilderness Society released a proposal for the nomination of most of Tasmania's North West Forests as a World Heritage Area. The area to be nominated is presented under the Society's own name of *Tarkine Wilderness Rainforest World Heritage Area*. A substantial document prepared by the Tasmanian Conservation Trust (Harries, 1992) for the Australian Heritage Commission provides the scientific background for the Wilderness Society's proposal. The document is titled *Forgotten Wilderness: North West Tasmania*.

This review deals primarily with the issue of whether or not certain geological/geomorphological features which are identified in the Wilderness Society's proposal actually satisfy the criteria for World Heritage Listing. Matters in the proposal which are relevant to the mineral exploration and mining industries are also addressed. These industries would lose their existing legal rights if the proposed World Heritage Listing goes ahead and if a National Park is created.

The review has been carried out by a professional geologist with twenty years experience of field work in Tasmania and who has been directly involved in working on the geology of the area of interest for the last ten years. This background has provided the reviewer with a good understanding of the nature of the features listed in the Wilderness Society's proposal, as well as experience in assessing scientific documents.

Plotting of the boundaries described by the Wilderness Society in their proposal defines an area of some 345 000 hectares, not the 390 000 hectares indicated in the proposal.

DISCUSSION OF FEATURES CITED IN THE PROPOSAL

(1) Overall geology of the area

The geology of the proposed World Heritage Area is cited (p.31) under Criterion 1, which relates to outstanding examples representing the major stages of the Earth's evolutionary history. Perhaps the authors believe that the regional geology has World Heritage value, although there is ambiguity in their wording.

The geological descriptions in both the proposal and in the principal source reference are very largely derived from previous work but with a new contribution on the Meredith Granite. The description given in the proposal is in the format of an outline of the evolutionary development of the geology and is consequently very interpretive. It is strongly influenced by views published in Burrett and Martin (1989) and does not draw on recently published accounts including Everard *et al.* (1992), Turner (1992), and Turner *et al.* (1992).

New data on the stratigraphy, metamorphism and geochronology (Turner *et al.*, 1992) of the old rocks which underlie most of the area of interest are difficult to reconcile with long-standing interpretations of their geological

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evolution. New interpretations are being developed but at this stage it is premature to claim either that the area of interest contains a microcosm of Tasmanian geology or that it exhibits outstanding examples of major stages of the Earth's evolutionary history.

(2) Marine-cut coastal benches

These geomorphological features are cited (p.31) under Criterion 1 as outstanding examples representing major stages of the Earth's evolution. They are briefly described in the proposal and also in the principal source reference, where descriptions by earlier workers are listed.

Again there is a sense of ambiguity about the citation of these features. Their scientific interpretation is presented in a tentative style rather than in a manner which indicates that their place in the evolution of the Earth has been confidently and exactly established.

No comparative evidence is presented to show that the benches are outstanding examples in terms of the Earth's evolution. Such benches occur widely around Tasmania and on the Bass Strait islands, and these other benches are interpreted in a similar way to those in the area of interest (Scanlon *et al.*, 1990; Colhoun, 1989).

(3) Karst in magnesite

The authors of the proposal assigned particular importance (p.ii) to karst phenomena developed in magnesite/dolomite lenses in the Bowry Formation in the Arthur Lineament. These karst phenomena are cited under both Criteria 2 (p.38) and Criteria 3 (p.45), which means that the phenomena are regarded both as outstanding examples representing significant ongoing geological processes and as superlative natural phenomena.

Little description of the karst phenomena is offered in the proposal but there are brief descriptions of the specific features in the principal source reference. There appears to be no previous literature concerning the phenomena, other than their mention in geological reports prepared by mineral exploration companies. The specific features identified include small surface-opening caves without decoration (stalagmites, etc.), outcrops shaped by dissolution, possible karst springs, sinkholes and subsurface cavities intersected during diamond drilling.

On page 38 it is claimed that "no significant karst systems in magnesite anywhere in the world are recorded in the accessible literature" and consequently the "karst in the Arthur Lineament magnesites constitutes a feature of outstanding significance on a global scale". Neither the classes of literature researched during the formulation of this claim nor the method(s) of accessing the literature are specified. On page 45 the claim regarding karst in magnesite in the Arthur Lineament becomes "as far as can be determined, it is globally unique".

Journals held in the Division of Mines' public library in Hobart can fairly be regarded as readily accessible literature. The journals contain references to specific karst features in magnesite in Brumado Bahia, Brazil (Bodenlos, 1954); in Central Ceará, Brazil (Bodenlos, 1950); and in California (Hess, 1908; Gale, 1912). These features include outcrops shaped by dissolution (Hess, 1908; Gale, 1912; Bodenlos, 1950; 1954); surface-opening caves (Bodenlos, 1954); and cavities exposed in underground workings (Hess, 1908), some of which were large enough to be used as ore-shutes. In deposits in Quebec, magnesite is markedly less soluble under the prevailing field conditions than dolomite (Osborne, 1938; Wilson, 1916), and the same is true for magnesite compared with limestone in the western USA (Hess, 1908).

Searches for relevant literature references in various electronic databases were made through the Division of Mines' library (Appendix 2). The same search facilities are readily accessible to the general public through the State Library. There are numerous references in the electronic databases to magnesite throughout the world but only six references were found for which karst and/or caves also appear as keywords in the databases (e.g. Klir, 1968). Our conclusion is that very little geomorphological and hydrological research has been carried out specifically on karst systems in magnesite. This view is reinforced by the treatment of karst in text books (e.g. Small, 1972; Thornbury, 1954), in benchmark collections (e.g. Sweeting, 1981), and in collections of regional descriptions (e.g. Herak and Stringfield, 1972). In these works the extensive karst systems developed widely in limestone are given much greater emphasis than karst in other less soluble or less common rocks, particularly poorly soluble magnesite which only occurs as comparatively small formations.

The apparent lack of specific research on karst in magnesite should not be interpreted as a lack of development of the phenomena. The documents cited above demonstrate that karst features are associated with magnesite bodies in various climatic conditions on three other continents in addition to Australia. However, with the exception of Klir (1968), the documents are geological reports in which karst forms are only referred to in passing. A notable case in point is provided by Ilavsky *et al.* (1991), who include a cross-section of the Czechoslovakian Jelsava deposit which shows karst cavities cross-cutting interbedded dolomite and magnesite but the authors make no mention of karst phenomena in their text.

To search the large number of magnesite references that are identifiable through the electronic databases and other reference listings for non-keyworded material was regarded as too great a task to be undertaken at present. However, the references identified so far provide a sound basis for the inference that karst features are probably associated with magnesite wherever it occurs as rock formations. Substantial formations of magnesite occur in many countries, with the major deposits occurring in Austria, USSR, Korea, Manchuria, Brazil, Canada, Australia, Nepal, USA, Greece and Turkey (Lefond, 1983). Other important deposits occur in China, Czechoslovakia, Yugoslavia, Spain, India and South Africa.

It is clear from our searches that the Wilderness Society's claim that "no significant karst systems in magnesite anywhere in the world are recorded in the accessible literature" is incorrect. Their further implication that the karst in magnesite in the Arthur Lineament is globally unique is quite unjustified.

(4) *Joint-controlled drainage on the Meredith Range*

This feature is also assigned particular importance (p.iii) in the proposal. It is cited under Criterion 2 (p.40) as an outstanding example representing significant ongoing geological processes. It is also cited under Criterion 3 (p.45) as an example of a superlative natural phenomenon.

The nature of the phenomenon is only briefly outlined in the proposal but the description in the principal source reference is detailed and is a substantially new contribution. The joint-related features on the Meredith Range were previously noted by Groves *et al.* (1972) and were mapped by McClenaghan in Turner *et al.* (1991).

The term rectilinear, which is used to describe the drainage pattern on the Meredith Range in the proposal, does not appear to be in wide usage for describing drainage patterns (Bates and Jackson, 1980; Fairbridge, 1968). Instead, the term rectangular is commonly used for patterns showing right angle bends and stream sections of similar length. A more precise term in the case of the Meredith Range is angulate because the streams display acute/obtuse angular relationships rather than 90° relationships. At one time some workers made no distinction between trellised and rectangular patterns (Zernitz, 1932), and this appears to be the case with Hills (1963).

No actual comparisons are made by the authors of the World Heritage Area proposal to support their assertion that the drainage pattern on the Meredith Range is outstanding and superlative. Our assessment is that it is about as well developed as the drainage pattern which is controlled by joints in granite in the Murrindindi area of Victoria (Hills, 1963) whilst the pattern in the Adirondacks, USA (Zernitz, 1932; Thornbury, 1954) seems better developed. Other examples of rectangular drainage patterns include the fjordland of southwest Norway, in which the rectangular pattern (Zernitz, 1932) is described as conspicuous, whilst the gorge of the Zambesi River downstream of the Victoria Falls is strikingly rectangular due to control by joints in the basalt country rock (Zernitz, 1932) and is already listed as a World Heritage feature (UNESCO, 1992). It seems likely that Ausable Chasm in New York, USA (Zernitz, 1932) would also be striking. Certainly the Ruined City in Arnhem Land (Hills, 1963) is an outstanding and superlative example of a joint-controlled (angulate) drainage pattern.

Our conclusion is that the drainage developed on the Meredith Range is representative of the class of stream patterns known as rectangular or, more precisely, angulate. In comparison with the Ruined City, the gorge of the Zambesi River below Victoria Falls, probably Ausable Chasm and probably

southwest Norway, the Meredith Range drainage is neither outstanding nor superlative.

(5) *Fold structure control on geomorphology*

The fold controlled geomorphology associated with the Huskisson syncline is cited (p.41) under Criterion 2 as an outstanding example representing significant on-going geological processes.

A very brief outline of the nature of the phenomenon is provided in the proposal. Little additional material is given in the principal source reference. The Huskisson syncline was mapped by Brown (1986) and this mapping was included in Turner *et al.* (1991).

No comparative evidence is provided by the authors of the World Heritage area proposal to justify their claim that the feature is outstanding. It is not. Features of similar quality occur in Tasmania south of Zeehan and in the Florentine Valley-Tiger Range area. None of these examples of fold-controlled geomorphology are as clear and detailed as features in folded terrains in the arid and semi-arid parts of Australia (e.g. Hills, 1963) and in many other folded terrains elsewhere in the world (e.g. Badgley, 1959; Holmes, 1965).

(6) *Meredith Range granite landscape*

The landscape of the Meredith Range is cited (p.44) under Criterion 3, which relates to superlative natural phenomenon. However, in the citation the area is simply said to have a distinctive granite landscape. This is true but it does not satisfy Criterion 3.

(7) *Sandy Cape and Lagoon landscapes*

Taken together these landscapes encompass the country extending westwards from the Norfolk Range to the coast. The landscapes are cited (p.45) separately under Criterion 3 but the authors view them as having coherence. A brief outline of their constituent features is given in the proposal and a more complete listing is given in the principal source reference.

The idea of landscape encompasses more than just the geological/geomorphological aspects of a piece of country. It also includes vegetation, cultural features and the general condition of the area's natural values. For this reason comment on the World Heritage value of the Sandy Cape and Lagoon landscapes is outside the scope of this review except to the extent that the comments made on geological/geomorphological features elsewhere in the review are relevant (see Items 2, 8). The concept of landscape seems ill-defined at this time.

(8) *Sandy Cape dunefields*

The dunes at Sandy Cape are cited (p.45) under Criterion 3 as superlative natural formations. No description of the dunes is

given in the proposal but a summary of the findings of previous workers is provided in the principal source reference. The dunes are 'blow-out' types reaching up to 60 m in height and extending several kilometres inland. They are already listed on the Register of the National Estate.

The authors of the World Heritage Area proposal provide no comparative evidence that the Sandy Cape dunes are either outstanding or superlative in an international context. In Tasmania they are only one of a number of examples of well-developed coastal dune systems. Other good examples occur at Ocean Beach (Scanlon *et al.*, 1990); Waterhouse-Gladstone area (Baillie *et al.*, 1979), Ahrberg Bay (Gee *et al.*, 1969), and on the Bass Strait islands.

OTHER MATTERS

The leasehold rights of prospectors and miners which currently apply in the North West Forests are not recognised in the Juridical section of the World Heritage Area proposal. Nor is the matter of revocation of these leases considered, and its likely consequence of compensation claims. Revocation would occur if the preferred tenure of the proposal was achieved, that is, if the area were to be listed as a World Heritage Property and become a National Park.

Currently there is an active mining operation for silica flour near Corinna with a dependent processing plant at Burnie. A small tin mining operation is being developed at Tulloch Creek. Ochre deposits at Main Creek and Bowry Creek are at an advanced stage of commercial assessment, with trial batches already in production. Mining Leases have either been granted or are under application for each of these operations, and there are a number of other Mining Leases in the area.

Retention Licences are held over substantial magnesite deposits near Arthur River and near Lyons River. Considerable funds have been spent in proving these deposits. Magnesite and magnetite deposits around Main Creek and Bowry Creek are covered by the Mining Leases (under application), which also cover the ochre deposits, and by a Retention Licence. Retention Licences, together with Exploration Licences which are current elsewhere in the proposed World Heritage Area, could be subject to revocation if the Wilderness Society's proposal goes ahead.

The party who seeks to have an area listed as a World Heritage Property is not required to consider alternative community values in the area of interest. However, it is incumbent upon the nominating authority, the Commonwealth Government, to do so. The past, present and future value to the Tasmanian community of mineral resources in the North West Forests is outlined in the Mines Division publication titled *Mineral Resources in Tasmania's North West Forests*. This publication also outlines procedures and regulations which have been put in place to protect natural values in areas such as the North West Forests during mineral exploration and mining.

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APPENDIX 1

Format of the proposal — derived from the format of the Tasmanian Wilderness World Heritage Area nomination

NOMINATION

1. SPECIFIC LOCATION

1 (a) Country

Give full name of State Party on whose territory property is located.

1 (b) State, province or region

Give full name of state, Province or Region where property is located. If property overlaps State, Provincial or Regional boundaries, provide names of all overlapped States, Provinces and/or Regions.

1 (c) Name of Property

Local name of property and other names by which property is known, to be provided. In case a change of name has occurred, provide name(s) by which property was previously known.

1 (d) Exact location on map and indication of geographical co-ordinates

Maps and plans showing exact location and boundaries of property are essential (see 3b below). Please provide latitude and longitude co-ordinates and/or a grid reference. For grid references, the type of grid should also be given.

For properties in urban areas, the name of the town or city, and the street and number, should be added.

If an area surrounding nominated property is considered essential for the protection of the property, e.g. a buffer zone, indications should also be provided on the boundaries of this area.

2. JURIDICAL DATA

2 (a) Owner

Specify the name and address of the current owner(s) of property.

2 (b) Legal status

Indicate the category of ownership (public or private) and in the case of privately owned property, whether public acquisition is in process or being considered. Provide details of protective, legal and administrative measures envisaged or already taken for the conservation of the property (e.g.

creation of national park). Give details on the state of occupancy of the property and its accessibility to the general public.

2 (c) Responsible administration

Give name(s) and address(es) of body (bodies) responsible for administration of property.

3. IDENTIFICATION

3 (a) Description and inventory

A detailed description of the property is to be provided. The property should fall into one of the following categories, defined in Articles 1 and 2 of the Convention.

Cultural Heritage

“monuments: architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science;

groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science;

sites: works of man or the combined works of nature and of man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological points of view.”

Natural Heritage

“natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view;

geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation;

natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.”

Give the size of the area of the property and, where applicable, of the buffer zone. The description should include precise details on the particular characteristics of the property. Details of the present and/or proposed use of the property should be included in this description.

3 (b) Maps and/or plans

Detailed maps showing the location and boundaries of the property (see section 1d above) should be attached to this form, referring to official survey maps where possible.

For properties which are located in urban areas, it may be necessary to use, in addition to a small-scale map on which the geographical co-ordinates will be indicated, a large-scale map or a detailed plan so that the location of the property will be accurately indicated. List under item 3b the maps and/or plans attached.

3 (c) Photographic and/or cinematographic documentation

Supporting documentation in the form of photographs, slides, etc. may be attached. List under section 3c all such documentary items, and indicate source.

3 (d) History

As far as cultural property is concerned, information may be supplied on the following:

- for monuments and groups of buildings: the period(s) represented, with the date(s) of construction and name(s) of principal architect(s) if known; original condition and subsequent changes; original and later functions;
- for an archaeological site: its origin; subsequent principal changes in terms of form, group occupying site, significance, etc.; year of discovery and name of archaeologist concerned if appropriate.

For property located in zones where natural disasters may occur (earthquakes, landslides, floods etc.), provide all relevant data; for instance, in the case of a property in a seismic zone, give details on all previous seismic activity, and the precise location of the property in the seismic calculations etc.

As far as natural property is concerned information may be supplied on the following:

- natural history of the site
- present and past modifications by man of the natural property including information on human population and settlements within the natural heritage site;
- history of the natural property as a conservation unit.

3 (e) Bibliography

List but do not attach all published material that includes important references to property, and which provided sources for the compilation of this nomination.

4. STATE OF PRESERVATION/CONSERVATION

4 (a) Diagnosis

Describe the present condition of the property. In cases where the property is in imminent or potential danger, provide details.

4 (b) Agent responsible for preservation/conservation

Give name and address of body or bodies responsible for state or preservation/conservation of property (as distinct from administrative responsibility — see item 2c above).

4 (c) History of preservation/conservation

Provide details of preservation/conservation work undertaken on property and of preservation/conservation work that is still required.

4 (d) Means of preservation/conservation

Under this item information should be provided on actual or pending laws or policies which establish the property as a conservation unit, on the technical means available, on the institutional context in which the property is managed, as well as on the financial resources available for preservation/conservation of the property.

4 (e) Management plans

Give details of any relevant existing local, regional or national plans (urban development, land reform, etc.) and their implications for the property.

5. JUSTIFICATION

A statement to be made on the significance (i.e. its "outstanding universal value" in the terms of the Convention) of the property that justifies it for inclusion in the World Heritage List. Property will be evaluated against the following criteria adopted by the World Heritage Committee:

- (a) For cultural property, outstanding universal value will be recognised when a monument, group of buildings or site — as defined in Article 1 of the Convention — submitted for inclusion in the World Heritage Lists is found to meet one or more of the following criteria. Therefore, each property should:
 - (i) represent a unique artistic achievement, a masterpiece of the creative genius; or
 - (ii) have exerted great influence, over a span of time or within a cultural area of the world, on developments in architecture, monumental arts or town planning and landscaping; or

- (iii) bear a unique or at least exceptional testimony to a civilisation which has disappeared; or
- (iv) be an outstanding example of a type of building or architectural ensemble which illustrates a significant stage in history; or
- (v) be an outstanding example of a traditional human settlement which is representative of a culture and which has become vulnerable under the impact of irreversible change; or
- (vi) be directly or tangibly associated with events or with ideas or beliefs of outstanding universal significance.

In every case, consideration must be given to the state of preservation of the property (which should be evaluated relatively, in comparison to the state of preservation of other property dating from the same period and of the same type and category).

In addition, the property should meet the test of authenticity in design, materials, workmanship or setting; authenticity does not limit consideration to original form and structure but includes all subsequent modifications and additions, over the course of time, which in themselves possess artistic or historical values.

- (b) For natural property, outstanding universal value will be recognised when a natural heritage property — as defined in Article 2 of the Convention — submitted for inclusion in the World Heritage List, is found to meet one or more of the following criteria. Therefore, properties nominated should:
 - (i) be outstanding examples representing the major stages of the Earth's evolutionary history; or
 - (ii) be outstanding examples representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment; as distinct from the periods of the Earth's development, this focuses upon ongoing processes in the development of communities of plants and animals, landforms and marine and freshwater bodies; or
 - (iii) contain superlative natural phenomena, formations or features, for instance, outstanding examples of the most important ecosystems, areas of exceptional natural beauty or exceptional combinations of natural and cultural elements; or
 - (iv) contain the most important and significant natural habitats where threatened species of animals and

plants of outstanding universal value from the point of view of science or conservation still survive.

It should be realised that individual sites may not possess the most spectacular or outstanding single example of the above, but when the sites are viewed in a broader perspective with a complex of many surrounding features of significance, the entire area may qualify to demonstrate an array of features of global significance.

In addition to the above criteria, the sites should also meet the conditions of integrity:

- The areas described in (i) above should contain all or most of the key inter-related and interdependent elements in their natural relationships; for example, an "Ice Age" area would be expected to include the snow field, the glacier itself and samples of cutting patterns, deposition and colonisation (striations, moraines, pioneer stages of plant succession, etc.).
- The areas described in (ii) above should have sufficient size and contain the necessary elements to demonstrate the key aspects of the process and to be self-perpetuating. For example, an area of "tropical rainforest" may be expected to include some variation in elevation above sea level, changes in topography and soil types, river banks or oxbow lakes, to demonstrate the diversity and complexity of the system.
- The areas described in (iii) above should contain those ecosystem components required for the continuity of the species or of the objects to be conserved. This will vary according to individual cases; for example, the protected area for a waterfall would include all, or as much as possible, of the supporting upstream watershed; or a coral reef area would be provided with control over saltation or pollution through the stream flow or ocean currents which provide its nutrients.
- The areas described in (iv) above should be of sufficient size and contain the necessary habitat requirements for the survival of the species.

In the case of migratory species, seasonable sites necessary for their survival, wherever they are located, should be adequately protected. The Committee must receive assurances that the necessary measures be taken to ensure that the species are adequately protected throughout their full life cycle. Agreements made in this connection, either through adherence to international conventions or in the form of other multilateral or bilateral arrangements, would provide this assurance.

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APPENDIX 2

Karst in magnesite — reference search by M. J. Ellis and N. J. Turner

A number of electronic databases in the ORBIT Network were searched. These databases were:

GEOREF

- Provides extensive coverage of over 5000 journals as well as conference proceedings, government documents, maps, monographs, books and theses in 29 geological fields of interest including historical geology, stratigraphy, structural geology, hydrogeology, engineering and environmental geology, surficial geology, geomorphology, Quaternary geology etc.
- Worldwide coverage includes documents in over 40 languages.
- Covers North American geology from the year 1785, and from 1959 for other regions.
- In October 1992, the database held 5,904,469 records.

GEOBASE

- Covers worldwide literature on geography, geology, ecology and related disciplines.
- Coverage — Worldwide 1980 to present.
- At June 1991, the database contained over 440,000 records.

ENVIROLINE

- Provides coverage in the environmental and resources areas of the journal literature, conference proceedings, government reports etc. Covers land environment, resource management, land use and misuse, terrestrial resources etc.
- Contains over 140,000 records (at June 1990) from 1971 to present.

In addition, State Library staff conducted a quick search on the earth science and environmental databases of the DIALOG Network, which also contains the GEOREF, ENVIROLINE and GEOBASE databases among others.

RESULTS OF DATABASE SEARCHES

Terms

Magnetit: (truncated so as to include magnetitic, magnetites etc.)

Karst: (also searches under karsts)

Cave: (also searches under caves and other terms starting with cave)

: symbol indicates truncation

Search strategy

NUMBER OF REFERENCES FOR EACH KEYWORD

	Magnetit:	Karst:	Cave:	Magnetit: + (karst: or cave:)
GEOREF	1308	14 416	16 901	6 references
GEOBASE	280	2 520	2 523	0 references
ENVIROLINE	12	66	157	0 references

A search of these terms, and the same databases (on the DIALOG Network) conducted by State Library yielded no references for the combination of magnesite and (karst or caves).

Subsequent searches were conducted specifically naming some of the major magnesite producing areas in the world. These searches were aimed at identifying general geological works (e.g. USGS Bulletins) on magnesite deposits in which geomorphological features might be briefly mentioned in the introductory sections but not necessarily show up in the keywords and hence the databases.

e.g.: Magnetit: + (Austria or Styria)
Magnetit: + Quebec etc.

The searches yielded in excess of 100 references.

In addition to searches on the automated databases, searches were undertaken in the Mines Division Library and the Sci-Tech Library at the University of Tasmania, with a number of useful references being retrieved.

The Bureau of Mineral Resources index of publications 1975–1984 yielded one reference on karst and one different article on magnesite, so further searching of BMR material was not pursued, nor was a manual search of the AESIS database.