



The Mineralogical Society of Victoria

Incorporated

A0001471E

Newsletter No. 203

February 2010



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The Mineralogical Society of Victoria Inc.
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Membership Details:

Joining Fee	\$5.00
City Adult Member	\$25.00
City Family membership (2 adults & children under 18)	\$35.00
Student Member (full time)	\$15.00
Country Adult member	\$20.00
Country Family Membership (2 adults & children under 18)	\$30.00
Newsletter only	\$15.00

(N.B. - Country membership - more than 50 km from Melbourne G.P.O.)

Applications for membership can be obtained by writing to:-

The Secretary, Ms. Lia Bronstijn,
P.O. Box 12162,
A'Beckett Street,
Melbourne, Vic, 8006.

General meetings are held on the 2nd Monday of each month (except January) commencing at 8.00 pm at the Royal Society of Victoria, 8 Latrobe St. Melbourne.

Visitors are most welcome.

Newsletter of the Mineralogical Society of Victoria
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FORWARD DIARY

PLEASE NOTE:- General Meetings of the Society are now held on the second Monday of each month,
8:00pm at the Royal Society Building.

Feb 8 General Meeting: Dr Kia Wallwork, Australian Synchrotron. Topic: To Be Advised

Feb 21 Mineral Appreciation Group – At Nunawading Lapidary Club Rooms, Silver Grove,
Nunawading.
Topic" Metamorphic Minerals – "Low Temperature" (<500°C)

Feb 28 Micro Group Meeting – At Volker Hoppe's home.
Topic: Minerals of the Northern Flinders Ranges. See comments in Micro Group report.

Mar 8 General Meeting: Speaker and Topic: To Be Advised

Mar 21 Micro Group Meeting – At Nunawading Lapidary Club Rooms, Silver Grove, Nunawading.
Topic: Minerals containing Lithium, Chromium, and Silver.

Mar 21 Mineral Appreciation Group – At Nunawading Lapidary Club Rooms, Silver Grove,
Nunawading. (Combined meeting with Micro Group).
Topic: Minerals containing Lithium, Chromium, and Silver.

Mar 27 Saturday Field Trip to Aerolite Quarry, Anakie.

OR

Mar 28 Sunday Field Trip to Flinders
See Excursions Report on Page 2 for details

MINERAL RELATED EVENTS

March 6,7 2010 Victorian Gemkhana, Morshead Park, Rubicon St, Ballarat

Apr 2 – 5 Gemboree, Devonport Recreation Centre, 24 Forbes St, Devonport, Tasmania

Jun 12 – 14 33rd Joint Mineralogical Societies of Australasia Seminar, The Royal Society
Rooms, Adelaide. Hosted by The Mineralogical Society of South Australia.

NEXT ISSUE

PLEASE NOTE:- Material for the April Newsletter to be with Michael Hirst by **March 24th**.

FROM THE COMMITTEE

On behalf of the Committee we would like to welcome everyone back to another year and hope you all had a safe and happy ‘holiday season’.



A reminder that the Annual Societies Seminar is being held in Adelaide this year over the usual Queen’s Birthday long weekend July 12-14. Details of the theme and registration details are expected shortly, but as always it would be wonderful to see as many Victorian members as possible attending and supporting the other State Societies.

As mentioned in the last Newsletter and at the December General meeting we shall be starting a Short Talk Roster this year. The Roster will be published in the next (April) Newsletter, so if you wish to get in early and select your favourite month or topic, please let a Committee member know.

Alex Blount
President

Special thanks to Jon Mommers (www.earthstones.com.au) for providing the printing services and allowing us to present the Newsletter in colour.

EXCURSIONS

Report

The Annual BBQ was held in December at Brimbank Park, and regardless of a few hiccups, a nice day was reportedly had by those who attended. There was some confusion about which Sunday the event was being held, and apologies to those who missed out. We’re still not quite sure where the error occurred but we shall have planning better organised for 2010! As the venue covers a very large area with a number of popular parking and picnic areas, there was some difficulty in finding the “MinSoc” area, but I believe we caught most of the people who arrived on the day.

Forward Diary

February: There will be no trip in February because of likely hot weather.

We are planning a field collecting trip in March to the Anakies quarries on Saturday 27th. At the time of writing, we don’t have confirmation back from the Quarry, so as a back-up option we are looking at a return to the (rocky) shores of Flinders. In the event that the Anakies trip doesn’t go ahead, the Flinders trip would take place on the Sunday 28th.



Some recent material collected at the Flinders sites has contained very fine mineral specimens and the quantity of rock present means that there is always the opportunity to add something to the collection.

Because of the communication needed to confirm/cancel these trips, please register your interest with Alex Blount so that we can advise details once confirmed. Either by phone, email or in person at the February meeting.

Alex Blount ablount@pb.com.au Mobile 0407 879 097

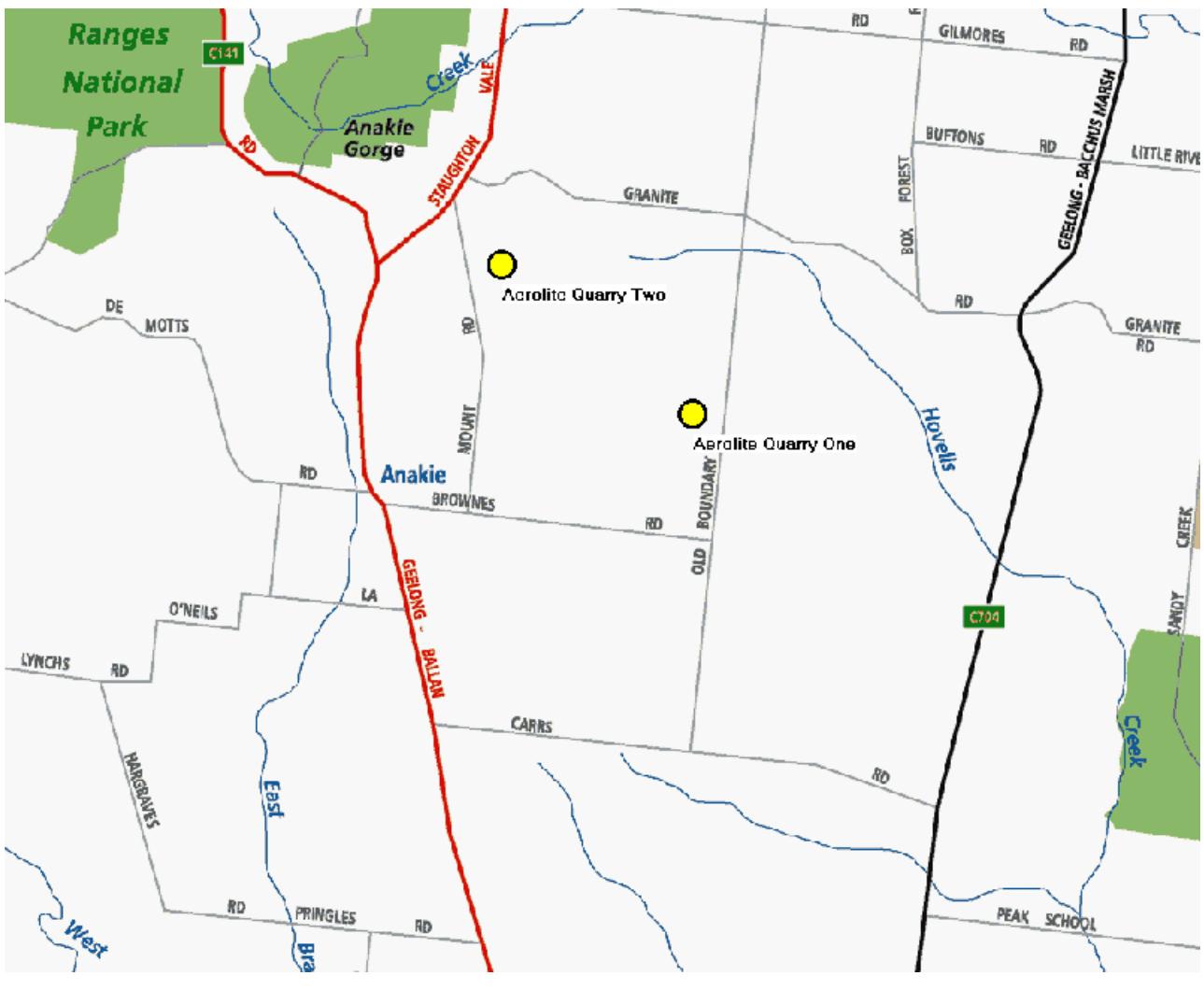
March 27th - Saturday

Anakies, Geelong

This has been tentatively arranged, and is to be confirmed at the March Meeting. Plan to meet at the Aerolite Quarries gate on Old Boundary Road at 9.30 AM. See map on page 3

If you are unable to attend the March meeting please contact John Haupt on 9876 3059 or john.haupt@bigpond.com to confirm that this trip is on. The usual safety requirements apply: Safety hard hat, safety glasses with side protection, steel capped boots preferred but must at least have sturdy boots, gloves, long trousers and long sleeved shirt and high visibility jacket.

Any suggestions of other field trip locations would be welcome.



PUBLICITY

Micro Group Report

The January meeting was held with the Mineral Appreciation Group at the NDLC rooms.

The topic, "Tasmanian minerals" gave collectors a chance to tell something of the field trips they had so much enjoyed. Brian spoke of the complex geology of Tasmania, with rocks of all major periods from Proterozoic to Cenozoic represented, as outlined in the new Catalogue of the Minerals of Tasmania. We were glad to have this book at hand for helpful and current information about minerals and localities.



Many specimens were tabled, both micros and hand specimens. Amongst these we noted vivianite, fluorite with ferroan magnesite, blue beryl with sellaite from Mt. Bischoff; an orthoclase crystal from Killiecrankie Bay, Flinders Island; wavellite and turquoise from the Australasian Slate Quarry, Back Creek, near Piper's River; stolzite, takanelite, andradite and epidote from the Kara Mine, Hampshire; crocoite in different habits from localities in the Dundas district, some with cerussite, some with vivid green pyromorphite; radiating crystal groups of natrolite from Cape Grim; lustrous mimetite in several colours from the Magnet mine; and boulangerite in filamentous crystals forming rings and a figure-of-eight, with rhodocrosite from the Hercules Mine, Rosebery.

Next Meeting: 28th. February at Volker Hoppe's home. Topic: Minerals of the Northern Flinders Ranges, i.e. north of Wilpena Pound. See map in the Catalogue of South Australian Minerals, p. 236, or, the Penguin Touring Atlas of Australia, p. 41.

March 21. The Micro Group will again meet with the MAG group at the Nunawading Lapidary Club rooms. Topic: Minerals containing Lithium, Chromium, and Silver.

April 25. At Jo & David Price's home. Topic: Type Localities.

The Group welcomes new members. Our meetings are informal and tea, coffee and cake are provided. It's only necessary to bring your lunch, microscope and any minerals you may have for the day's topic.

No minerals? No problem – come anyway as many minerals will be tabled for all to see, but if you haven't attended one of these meetings before, do let the host of the day know you are coming so that there will be enough seats for everyone.

Mineral Appreciation Group Report

In January the group met again with the Micro Group for a combined topic "Minerals of Tasmania". Again this proved to be quite a successful gathering allowing a range of species, localities and specimen sizes to be observed. As Jo has already provided a thorough report on the meeting above, I won't go into details.

With the NDLC venue providing good facilities for the numbers attending, and the combined meetings allowing an extra 'spare' weekend each month for excursions and other activities, a discussion was held and decided to trial semi-regular combined meetings of the Micro and Mineral Appreciation Groups. Nominally 2-3 times each year. Any attendees with comments or opinions on these combined meetings are encouraged to raise them with the groups.

The meetings are an open show and discussion format and all society members are welcome to attend. Meetings typically aim for people to arrive around 10:00am for a 10:30am start, allowing time for people to unpack specimens. If you wish to attend, have any questions or have suggestions for topics you would like to see covered then please catch up with Alex Blount.

RESOURCES, NEW PUBLICATIONS & REFERENCES OF INTEREST

If any Society members become aware of new publications relevant to mineralogy or existing items that they feel would be of benefit to members, please feel free to let a committee member know. Where appropriate, the Society can look to obtain copies for inclusion within the library.

New journals, publications and newsletters received include:

The Mineralogical Record

Nov-Dec 2009

Famous mineral localities: Volodarsk-Volynski, Zhitomir Oblast, Ukraine

The Braen quarry, Haledon, Passaic County, New Jersey



Rocks & Minerals – Nov-Dec 2009

- A History of Mineral Collecting at the Chino Mine, Grant County, New Mexico
- The Joaquín Folch Girona Mineral Collection, Barcelona, Spain
- The Graphites of New York: Scientific and Aesthetic Surprises
- Tanakamiyama, A Classic Japanese Pegmatite District

International Micromounters Journal – Nov 2009

Newsletter of Micro Collectors of New Zealand – “Micro-Scope” – Dec 2009

The library shelves are now in approximate order. There are lots of fascinating books on mineralogy and related topics, just waiting for members to borrow and enjoy them – so, happy hunting and good reading!

SOCIETY MICRO-MINERAL COLLECTIONS

Broken Hill Collection – Alex Blount

Iron Monarch Collection – Alex Blount

Victorian Collection – Alex Blount

Western Australia – Growing rapidly and soon to be available to borrow!!

The collections currently contain over 600 micro-mineral specimens from their respective regions. We are always looking for new donations of specimens (preferably mounted but not essential), especially from new or recent finds, but updates or multiples of existing species are also appreciated.

The collections are available to all members to borrow on a monthly basis and they provide an excellent way to compare your own material from field-trips with ‘already identified’ reference specimens. If anyone wishes to borrow the collections or peruse a copy of the catalogue, please catch up with the curators listed above.

WANTED

Mineralogical Record Back Issues Vol 2 No 2 & Vol 2 No 5 for the **MinSoc Library**.

Please contact any committee member if you can assist with these.

FIELD NATURALISTS CLUB OF VICTORIA GEOLOGY SPECIAL INTEREST GROUP



Meetings take place at 8pm at the FNCV Clubrooms at 1 Gardenia Street, Blackburn, 3130 (Melway 47 K10) Further information on the talks and excursions is available from Rob Hamson, 9557 5215 AH, robhamson1949@hotmail.com, Clem Earp 9885 1548 AH or Noel Schleiger 9435 8408 AH.

Details of field trips appear in the issue of the *Field Nat News* published the month before the date of the excursion. As a voluntary organisation funded entirely by our members' subscriptions, we welcome visitors but there is a charge of \$2 per non-member for each meeting and \$5 per excursion attended to help cover our costs. Members of affiliated clubs pay \$2.50 for excursions.

Membership: Joint/Family \$85, Single \$65, Concession \$50, Student \$25. Further details from FNCV Office 9877 9860.

GEOLOGY CALENDAR

Contact Ruth Robertson 03 9386 5521 rutherob@hotmail.com

February

Wed 24th Evening meeting

Kanawinka Geopark- The Geology that forms the landscape, culture and communities of SW Victoria and SE South Australia. Speaker: Dr Juliet Bird, Honorary fellow, Melbourne University.

March

Wed 24th Evening meeting

Waste Management and Sustainability- Welcome to the Anthropocene. Speaker: Dr Trevor Thornton, School of life and Environmental Science, Deakin University.

April

Tues 13h- Excursion (half day)

The Synchrotron- Faster than a speeding bullet. The Australian Synchrotron, 800 Blackburn Rd Clayton.
Max no participants 20.

Sat 17th- Excursion.

Mt Piper- A significant flora and fauna habitat; thanks to its geology. Leader: Ian Julian, SW Goulburn landcare facilitator.

Wed 28th- Evening meeting

Something Old, Something New- The earliest and most recent invertebrate fossil discoveries in Victoria.
Speaker: Clem Earp, member FNCV.

May

Wed 26th- Evening meeting

Evolution and Anatomy of Early Devonian lungfish-Osteichthyes Dipnoi. Speaker: Alice Clement, Museum Victoria and Research School of Earth Sciences, ANU.

THE MINSOC TRADING POST

Society members can submit brief descriptions of specimens, equipment or other mineral related items that they wish to sell, swap or give away.

At General Meetings there are often some minerals for sale after the meeting.

This is open to all – feel free to bring your minerals along.

THE RARE EARTHS

Talk given at the October 2009 meeting

by John Haupt

The term Rare Earth was given by Johann Gadolin in 1794 for a group of minerals with similar properties. But they are neither rare nor are they earths! All except one are more abundant on earth than gold, silver, mercury or antimony (Figure 1). They are all metals. The term usually applies to the lanthanide group minerals (Atomic No's 57 to 71) and Yttrium (39) is often included because it has similar properties. Sometimes scandium (21) and thorium (90) are included as they too have similar properties.

The similarity of the rare earths is due to the configuration of their outer electrons, giving them a valency of 3 (hence their location in the 3rd column of the periodic table), see Figure 2. They are all silvery-white metals and readily react in air or water to form oxides.

Discovery

The individual elements were difficult to isolate from oxides which contain several of the elements. In 1751 Cronstedt described a heavy reddish ironstone which he named tungsten (heavy stone) from Bastnäs in the Riddarhyttan ore field west of Stockholm in Sweden. In 1803, Wilhelm Hisinger & Jons Berzelius analysed this material and identified the new ‘earth’ which they named ceria. At the same time Martin Klaproth at Berlin also discovered the new ‘earth’ in the same material. In 1787, Axel Arrhenius found a black mineral in the Ytterby quartz-felspar quarry on the island of Resaro in the Vanxholm provence near Stockholm, Sweden. This was identified by the chemist Johan Godolin to contain a new ‘earth’ which he named yttria. The elements that were contained in the oxides ceria and yttria were subsequently named cerium and yttrium.

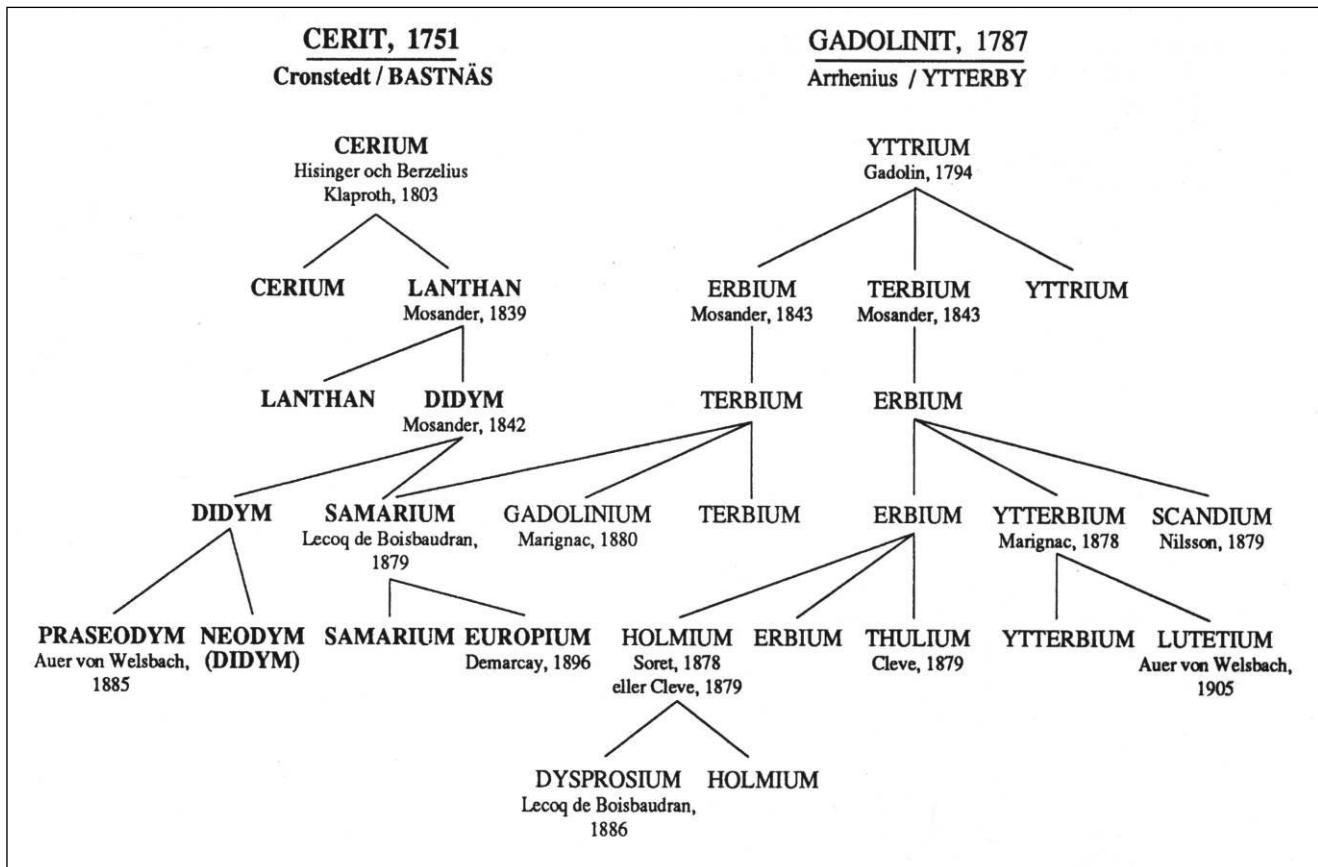
Between 1839 and 1843, analyses of specimens of yttria and ceria, principally by the Swedish chemist Carl Mossander (a student of Berzelius), found that they were mixtures of oxides that also contained other rare earth elements. The two that he found in ceria he named lanthana and didymia (the elements being lanthanum and didymium) and in yttria he discovered erbia and terbia (the elements were named erbium and terbium). Mossander had considerable difficulty in isolating the constituents as they had very similar properties.

After Mossander’s work, other chemists attempted to isolate other ‘rare earths’, but impurities from other elements led to numerous claims for other Rare Earth Elements (REE). In 1913-14, H. Mosley studied the X-ray spectra of the elements and found a direct relationship between the X-ray frequencies and the atomic numbers of the elements. He was able to clearly show that there could only be 15 lanthanoids (starting at lanthanum and finishing with lutetium). At that time all except element 61 had been discovered. No stable isotopes of 61 exist and it was not discovered until 1945, when one of its isotopes was discovered as a by-product of atomic fusion in a nuclear reactor and it was named promethium.

The Rare Earth Elements

<u>Element</u>	<u>Date discovered & discoverer</u>	<u>Named after</u>
Lanthanum	1839, Mossander	The Greek lanthanein – to lie hidden
Cerium	1803 Berzelius & Hisinger, Klaproth	The asteroid Ceres – discovered in 1801
Praseodymium	1885, Welsbach	The Greek prasios didymos – green twin
Neodymium	1885, Welsbach	The Greek neos didymos – new twin
Promethium	1945, Marinsky, Glendenin & Coryell	The Greek Prometheus–who stole the fire from the gods
Samarium	1879, de Boisbaudran	The mineral Samarskite
Europium	1901, Demarcay	Europe
Gadolinium	1880, de Marignac	Johann Gadolin, a Finnish chemist
Terbium	1843, Mosander	Ytterby, Sweden
Dysprosium	1886, de Boisbaudran	The Greek dysprositos – Hard to get
Holmium	1878, Cleve	The Latin Holinia – Stockholm
Erbium	1842, Mosander	Ytterby, Sweden
Thulium	1879, Cleve	Thule – ancient Scandinavia
Ytterbium	1878, De Marignac	Ytterby – Sweden
Lutetium	1907, Umain	Latin Lutetia – Paris

The sequence of discovery of the REE (After Ohlman et al in Rare Earths!)



REE Deposits

The rare earth elements do not occur in nature. Most are produced as an important by-product from the mining of other minerals.

The major producer of rare earth minerals is China from their major deposit at Bayan Obo in the Inner Mongolia Autonomous region. Here ore reserves are estimated at 57 million tonne, with 6% grade of rare earth oxides. It is principally an iron mine with hematite–magnetite ore. Bastnäsite and monazite are the major REE minerals.

The Mountain Pass Lanthanide ore deposit in California in the USA is the 2nd largest producer of REE. It is a carbonatite body with bastnäsite being the main REE. The deposit contains about 40% calcite, 25% barite, 10% strontianite, 12% bastnäsite, 8% silica and minor amounts of other minerals. The REE in content of the bastnäsite is: 50% cerium, 34% lanthanum, 11% neodymium, 4% praseodymium, 0.5% samarium, 0.2% gadolinium, 0.1% europium, 0.2% other REE.

In Australia, a small amount of REE has been extracted as a by-product from monazite in the beach sand deposits of Queensland and WA, which were principally mined for rutile (a source of titanium). REE minerals also occur in BHP Billiton's Olympic Dam deposit in South Australia, but is not recovered. However, there are two significant REE deposits and both are currently being developed. One is Nolans, 135 km NW of Alice Springs, the other is Mt Weld, 35 km south of Laverton in Western Australia.

The Nolans Bore is a rare earth-phosphate-uranium-thorium deposit currently being developed by Arafura Resources. They have constructed a trial extraction process at ANSTO at Lucas Heights in Sydney. The Chinese company ECE, recently acquired 25 % of Arafura.

The Mt Weld deposit is being opened up by the Lynas Corporation. They recently sought finance to develop the deposit, with a Chinese company seeking to acquire 50% of their operation. This was dropped following the conditions imposed by the Foreign Investment Review Board.. A concentration plant is being constructed on-site and a treatment plant is being built in Malaysia. The deposit is in laterite which overlies an alkaline carbonatite complex. The deposit is being mined by opencut, with the economic zone between 30 – to 60 m. The principal minerals being mined are niobium, titanium and REE.

The REE are important industrial minerals, many have a vital use in the electronics industry. (e.g. samarium is used in permanent magnet motors, europium is an important ingredient in red phosphors, lanthanum is used in the production of superconductors. The USA is concerned that China has a virtual monopoly in the supply of REE. Presumably China's interest in acquiring the Australian REE companies is aimed at retaining their monopoly.

REE Minerals

There are approximately 350 mineral species that contain one or more REE's. Some 200 contain cerium, 130 yttrium, 70 lanthanum and 50 neodymium. There are no species of europium, holmium, letucium, termium and thulium, but these elements are found as minor constituents in other REE species.

Most REE minerals have a subscript as part of their name which contains the chemical formula of the element of the dominant REE. (e.g. parasite-(Ce)). This is known as the Levinson modifier, named after the person who proposed its use to the International Mineralogical Association (IMA) in 1966.

The ionic radius of the REE decreases with their Atomic Number (the lanthanum ion is 20% larger than lutetium). It is common for elements with a similar ion size to exist within the crystal structure of a mineral, hence many of the rare earth minerals contain several REE elements. This is shown in their chemical formula (e.g. bastnäsite-(Ce):- (Ce,La)(CO₃)F, or decrespignyite-(Y):- (Y,REE)₄(Cu(CO₃)₄Cl(OH)₅.2H₂O.

Mineral localities

There are three notable localities that have produced excellent specimens of some of the REE minerals, as follows. The mineral from the type locality is shown in bold.

The iron mines at Basnäs in Sweden. These workings have produced the following REE minerals: allanite-(Ce), **bastnäsite-(Ce)**, **cerite-Ce**, **håleniusite-(La)**, lanthanite-(Ce), **percleveite-(Ce)** & **törnebohmite-(Ce)**.

The Tremouns talc quarry near Luzenac in southern France. Here REE minerals are aeschynite-(Y), allanite-(Ce), bastnäsite-(Ce), dissakisite-(Ce), **gatelite-(Ce)**, higganite-(Y), iimoriite-(Y), monazite-(Ce), parisite-(Ce), synchesite-(Ce), thortveitite, törnebohmite-(Ce), **trimounsite-(Y)** and xenotime-(Y).

Zagi Mountain in the North West Frontier of Pakistan. Here REE minerals occur in alpine veins in gneissic rocks. Excellent specimens of bastnäsite -(Ce), parisite-Ce), rhabdophane-(Ce) and xenotime-(Y) have been found. The area is remote and currently under conflict between the Pakistan military and the Taliban.

Some other localities are:

Mont Saint-Hilaire in Quebec, Canada. This is a world famous mineral locality, with some 373 species being recorded and another 15 yet to be described. Some 56 are REE minerals.

The Aris quarry in Windhoek in Namibia is also a source of REE minerals, with many species being in common with those found at Mont Saint-Hilaire.

Australia

Perhaps surprisingly, Australia is the type locality for 10 REE minerals as follows:

Mineral	Formula	Locality/ Date found
Arsenoflorencite-(Ca)	(Ca,La)Al ₃ (AsO ₄ ,PO ₄) ₂ (OH) ₆	Kimba SA (1987)
Davidite-(Ce)	(Ce,La)(Y,U,Fe ²⁺)(Ti,Fe ³⁺) ₂₀ (O,OH) ₃₈	Radium Hill SA (1906)
Davidite-(La)	(La,Ce)(Y,U,Fe ²⁺)(Ti,Fe ³⁺) ₂₀ (O,OH) ₃₈	Radium Hill SA (1906)
Decrespignyite-(Y)	(Y,REE) ₄ (Cu(CO ₃) ₄ Cl(OH) ₅ .2H ₂ O	Paratoo SA (2002)
Formanite-(Y)	YTaO ₄	Pilbara WA (1944)
Loveringite	(Ca,Ce)(Ti,Fe ³⁺ ,Cr,Mg) ₂₁ O ₃₈	Norseman WA (1978)
Lucasite-(Ce)	(Ce,La)Ti ₂ (O,OH) ₆	Argyle WA (1987)
Paratooite-(La)	(La,REE) ₃ (Ca,Sr) ₂ NaCu(CO ₃) ₈	Paratoo SA (2006)
Stillwellite-(Ce)	(Ce,La,Th,Ca)BSiO ₅	Mary Kathleen Qld (1955)
Tanteuxenite-(Y)	(Y,Ca,Ce)(Ta,Nb,Ti) ₂ (O,OH) ₆	Pilbara WA (1928)

Several other species of REE minerals have been found in Australia, some being:

Apart from being the type locality for two REE minerals, Paratoo, near Yunta in South Australia has also produced specimens of bastnäsite-(Ce), donnayite-(Y) and tenerite-(Y).

The Mary Kathleen mine in Queensland produced allanite-(Ce) and stillwellite-(Ce).

At Broken Hill specimens of agardite-(Y), bastnäsite-(Ce), churchite-(Y) & synchesite-(Y) have been collected from the Kintore & Block 14 opencuts.

The No 2 workings at Radium ridge at Mt Painter in Arkaroola have yielded specimens of francoisite-(Nd) & monazite-(Ce).

The Kingsgate mines in NSW have produced small crystals of cerianite-(Ce).

In Victoria, monazite has been found in alluvial gravels at several localities and listed in the Society's Special Publication 3 - Phosphate Minerals of Victoria.

References:

Rare Earths! The Mineralogical Record, May/June 2004, V35/3

The Not-So-Rare Earths, Scientific American, V258/1, Jan 1988

Uranium minerals from Mt Painter, Australian Journal of Mineralogy, V9/1, p24

Web Sites:

- www.chemical-elements.com/elements
- [www.britannica.com \(rare-earth element\)](http://www.britannica.com/rare-earth-element)
- <http://environmentalchemistry.com/yogi/periodic>

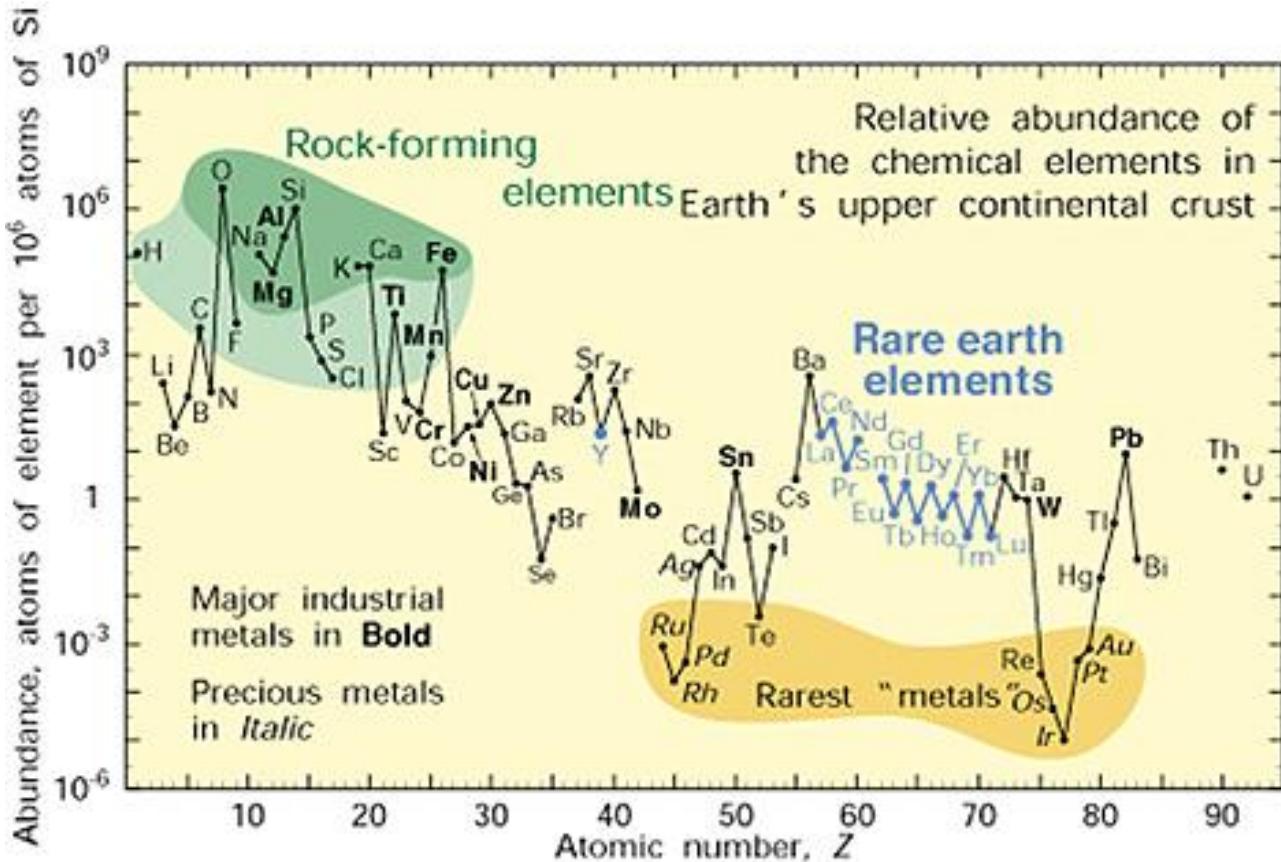


Figure 1 (above): Abundance of the elements in the Earth's crust.

Figure 2 (below): The Periodic Table of Elements.

Periodic Table of Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																																																																								
1 H Hydrogen 1.00794	2 He Helium 4.002602	3 Li Lithium 6.941	4 Be Beryllium 9.012162	5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.007	8 O Oxygen 16.00004	9 F Fluorine 18.000402	10 Ne Neon 20.179	11 Na Sodium 22.9898928	12 Mg Magnesium 24.3050	13 Al Aluminum 26.9815398	14 Si Silicon 28.0855	15 P Phosphorus 30.973752	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948	19 K Potassium 39.0963	20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.887	23 V Vanadium 50.945	24 Cr Chromium 51.995	25 Mn Manganese 54.938045	26 Fe Iron 55.845	27 Co Cobalt 58.93195	28 Ni Nickel 58.6954	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.9325	34 Se Selenium 78.98	35 Br Bromine 79.904	36 Kr Krypton 83.798	37 Rb Rubidium 85.4878	38 Sr Strontium 87.62	39 Y Yttrium 91.224	40 Zr Zirconium 92.90638	41 Nb Niobium 95.98	42 Mo Molybdenum 95.96	43 Tc Technetium 95.9072	44 Ru Ruthenium 96.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.862	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.780	52 Te Tellurium 127.50	53 I Iodine 126.90447	54 Xe Xenon 131.293	55 Cs Cesium 132.905419	56 Ba Barium 137.327	57-71 57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.084	79 Au Gold 196.956569	80 Hg Mercury 200.59	81 Tl Thallium 204.3933	82 Pb Lead 207.2	83 Bi Bismuth 208.96040	84 Po Polonium (208.9624)	85 At Astatine (209.9671)	86 Rn Radon (222.0176)	87 Fr Francium (223)	88 Ra Radium (226)	89-103 89-103	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub Ununbium (285)	113 Uut Ununquadium (284)	114 Uup Ununpentium (289)	115 Uuh Ununhexium (292)	116 Uuu Ununseptium (294)	117 Uus Ununoctium (294)	118 Uuo Ununoctium (294)

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

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Above left & right: Bastnasite-(Ce) crystals, approx. 1 cm, from Zagi Mountain, Pakistan.

Specimens: J. Mommers. Photos: J. Haupt

Below left: Monazite-(Ce) from Zagi Mountain, Pakistan. Crystal approx. 2 cm across. Specimen: J. Mommers. Photo: J. Haupt

Below right: Xenotime-(Y) from Zagi Mountain Pakistan. Crystal approx. 5 mm. Specimen: J. Mommers. Photo: J. Haupt.





Above: Cerianite-(Ce) crystals to 1 mm from Kingsgate, NSW.
Specimen: B&M Day. Photo: J. Haupt.

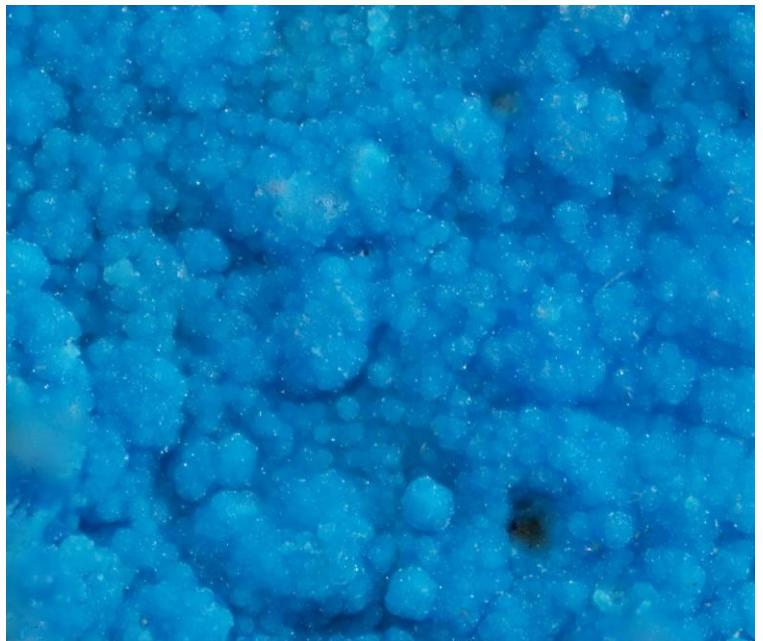
Right: Monazite grains from Amphitheatre, Victoria. FOV 6mm. Specimen & Photo: J. Rowe.

Below: Allanite-(Ce) 5 cm across. From Mary Kathleen, Qld. Specimen & Photo: J. Haupt.





Left: Paratooite-(La) crystals from Paratoo, South Australia. 3mm FOV. Specimen & Photo: J. Haupt.



Below: Decrespignyite-(Y) from Paratoo, South Australia. 4mm FOV. Specimen & Photo: J. Haupt.

Bottom left: Tengerite-(Y) from Paratoo, South Australia. 3mm FOV. Specimen & Photo: J. Haupt.

Bottom Right: Donnayite-(Y) from Paratoo, South Australia. 4mm FOV. Specimen & Photo: J. Haupt.

