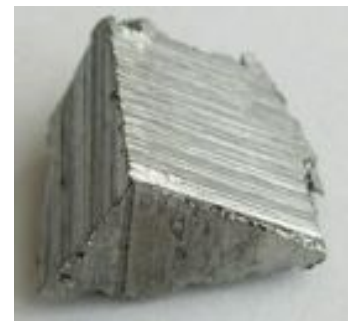
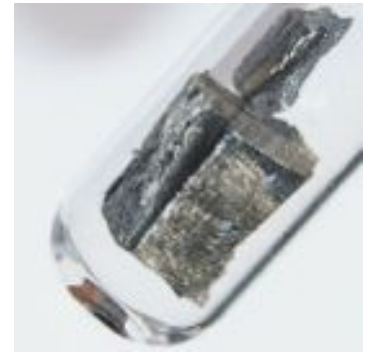
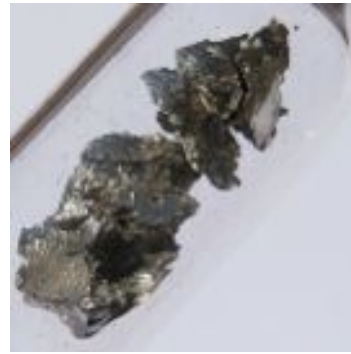
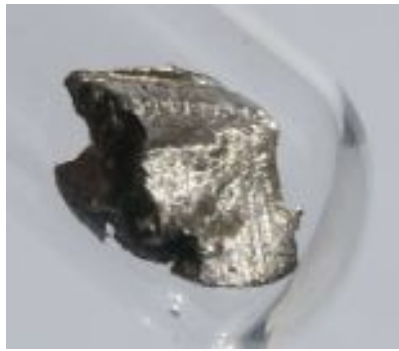


Group → ↓ Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	1 H																		2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F		10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl		18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br		36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I		54 Xe
6	55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At		86 Rn
7	87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus		118 Uuo
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu				
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr				

# Rare Earths

- Lanthanum 57 La
- Cerium 58 Ce
- Praseodymium 59 Pr
- Neodymium 60 Nd
- Promethium 61 Pm
- Samarium 62 Sm
- Europium 63 Eu
- Gadolinium 64 Gd
- Terbium 65 Tb
- Dysprosium 66 Dy
- Holmium 67 Ho
- Erbium 68 Er
- Thulium 69 Tm
- Ytterbium 70 Yb
- Lutetium 71 Lu
- (above are Lanthanides)
- Scandium 21 Sc
- Yttrium 39 Y



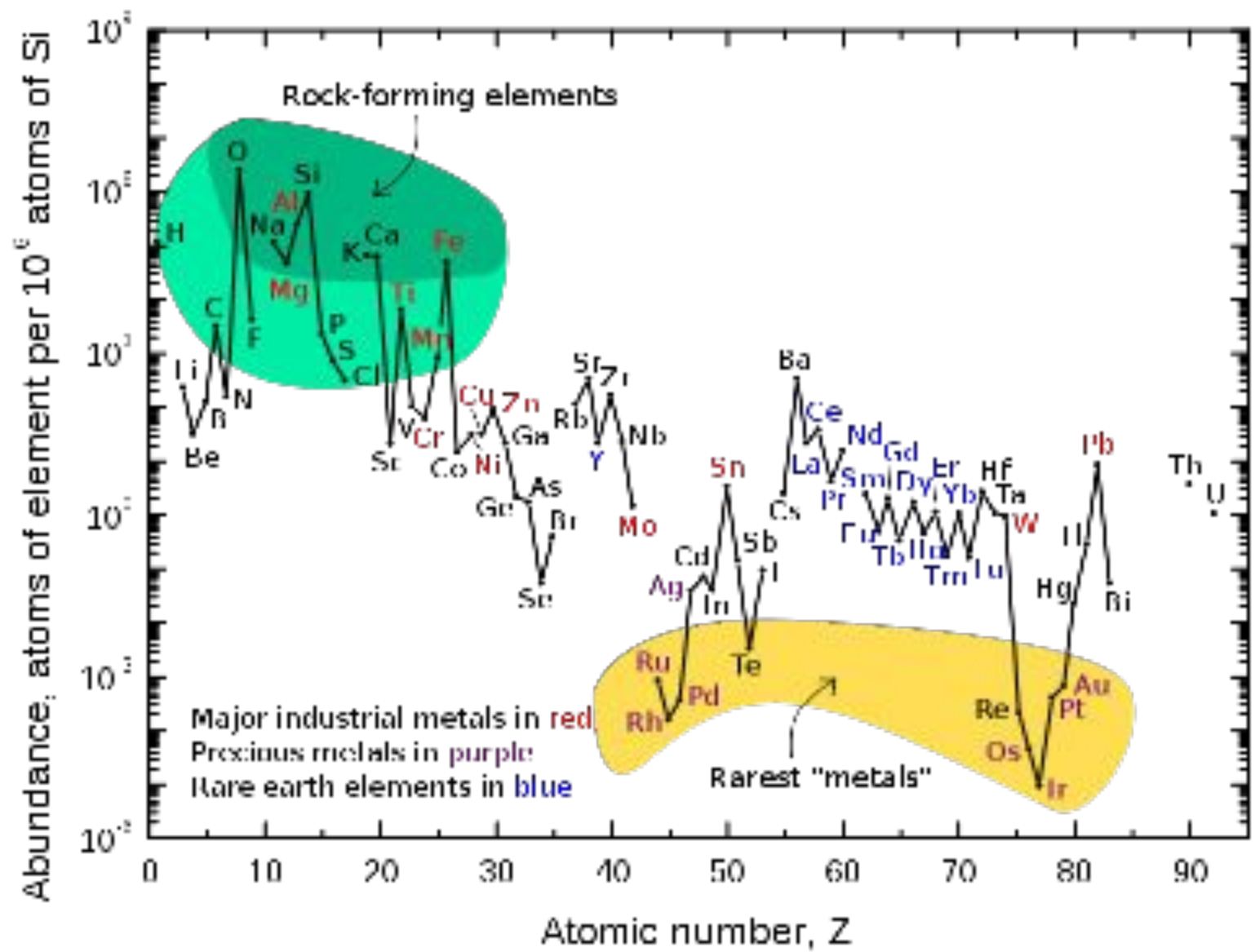


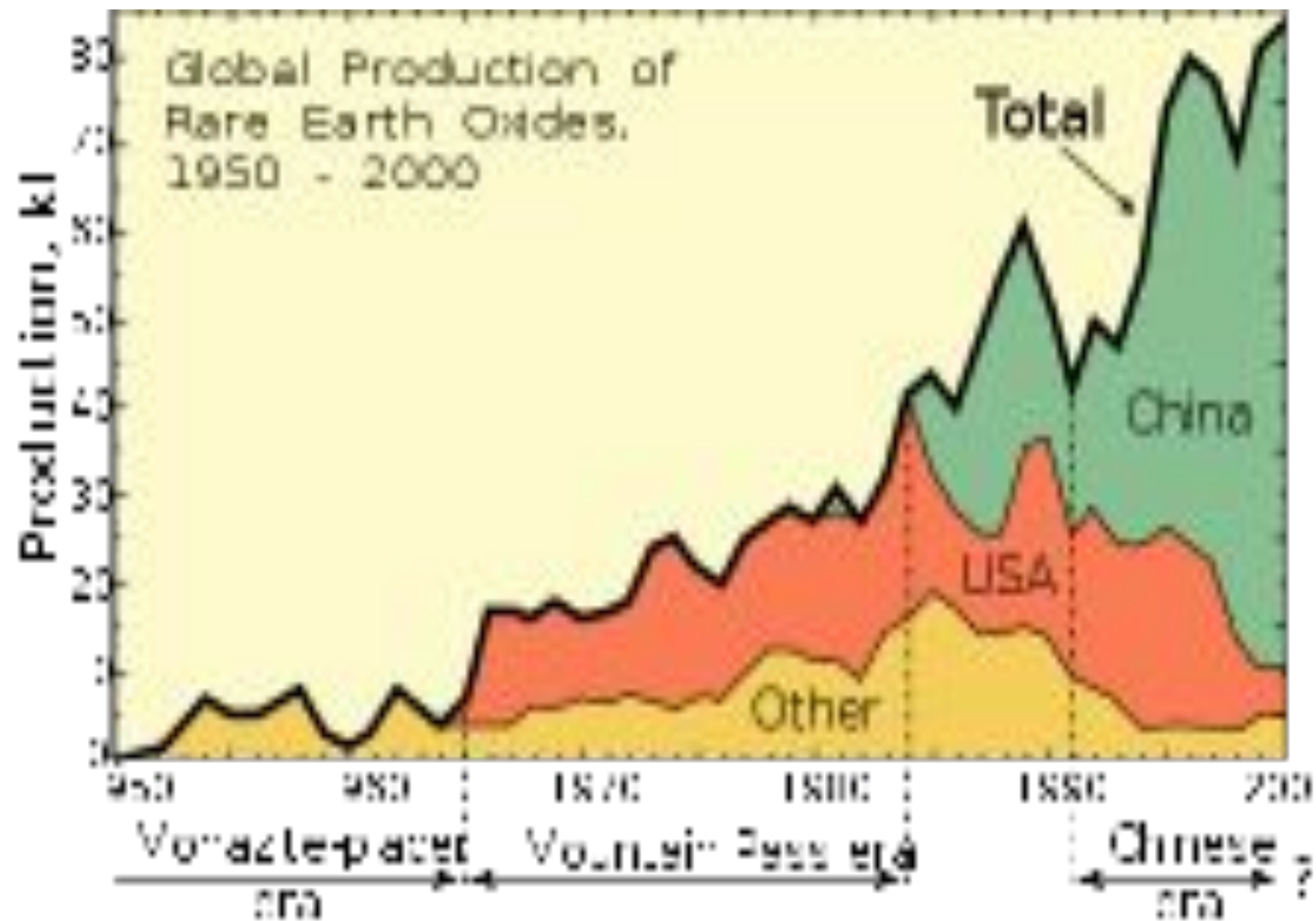
# Lutetium



Terbium.

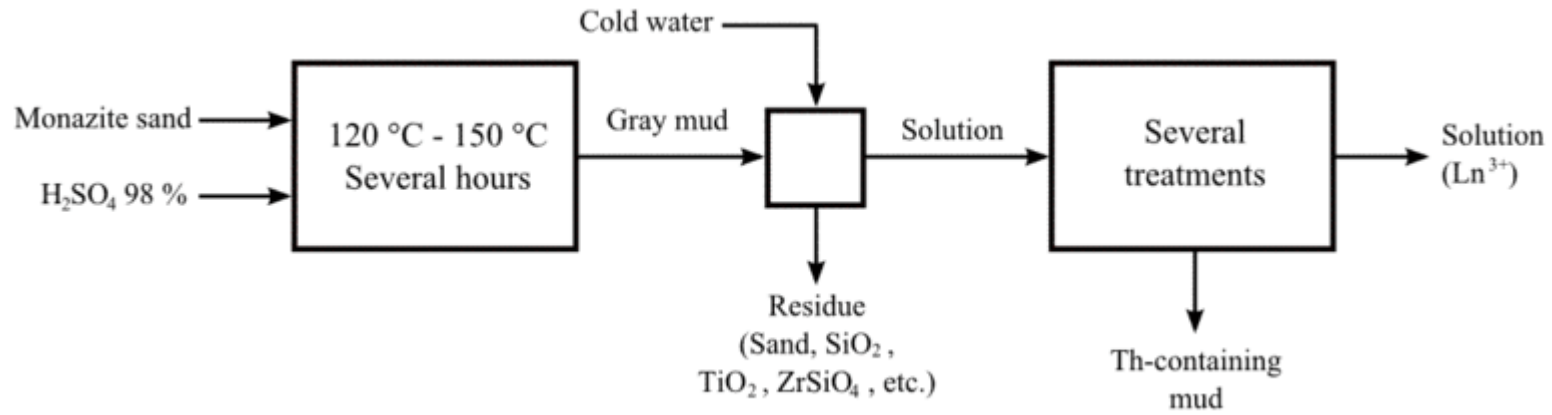








Processing La - a similar process is used for most REs.





# Rare Earth uses

- Many are used in lasers, magnets, special purpose lighting, computer memory, cameras etc, high temperature components, medical treatments, expensive sunglasses, and
  - So called (environmentally) green energy devices.
  - The first large-scale use may have been Sm in Sony Walkman (1979) as magnets.
  - Here are other uses, and a rough order of apportionment.
- CAT - car exhaust gases converters 45%
  - Petrol and oil refining 25%
  - Permanent magnets 12%
  - Glass polishing + ceramics 7%
  - Metallurgical processes 7%
  - Phosphors 3%
  - Other 1%

# How rare? Where?

- Cerium is the 26th most common element in the earth's crust; similar to Copper (Cu), Neodymium is more common than Gold (Au) Thulium the least common but is more abundant than naturally occurring Iodine (I) which is the 47<sup>th</sup> most rare element.
- Mainly mined in India, Brazil, S Africa until 1948, then California, until the 1990s when China started mining. China has become the world-leader forcing the price down until other countries ceased production. Some countries are re-starting operations, notably USA, Australia, Canada, Russia, Brazil,
- China has 35% of proven global deposits, and currently mines 95% of global production.
- Japan has 300,000 tonnes in recycled components! But needs it for electrical industries.
- The US-military is taking steps independently to procure materials for strategic purposes, free of foreign supply complexity.