

DATA & DEFINITIONS

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Characters

The names of characters, locations and events portrayed in this paper are fictitious (but fun). Enjoy!

Units and conversions

Degrees Celsius (°C) to Degrees Kelvin (K): $T_{(C)} = T_{(K)} - 273.15$

Physical constants

Constant	Symbol	Value
Speed of light	c	299,792,458 m/s effectively 3×10^8 m/s
Lightyear (distance)	ly	1 ly is approx. 9.46×10^{12} km
Parsec (distance)	pc	1 pc is approx. 3.26 lightyears
Universal gravitational constant	G	$6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$
Earth's gravitational acceleration	g	9.8 ms^{-2}
Earth mass	M_{\oplus}	5.98×10^{24} kg
Earth radius	R_{\oplus}	6.37×10^6 m
$g_{\text{planet}} = G \times M_{\text{planet}} / R_{\text{planet}}^2$		

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18												
1 H Hydrogen 1.01		3 Li Lithium 6.94	4 Be Beryllium 9.01	5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18	11 Na Sodium 22.99	12 Mg Magnesium 24.31	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95												
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.63	33 As Arsenic 74.92	34 Se Selenium 78.97	35 Br Bromine 79.90	36 Kr Krypton 84.80												
37 Rb Rubidium 84.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.25												
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.99	86 Rn Radon 222.02												
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium [unknown]	114 Fl Flerovium [289]	115 Uup Ununpentium [unknown]	116 Lv Livermorium [298]	117 Uus Ununseptium [unknown]	118 Uuo Ununoctium [unknown]												
57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium [144.91]	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.06	71 Lu Lutetium 174.97	89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.1	102 No Nobelium 259.10	103 Lr Lawrencium [262]

Periodic Table of the Elements courtesy of

<http://sciencenotes.org/category/chemistry/periodic-table-chemistry/>



Units of all ranks are in the process of being defined by Global Boundary Stratigraphic Points (GSSPs) and are being defined by Global Standard Stratigraphic Ages (GSSAs). Italic fonts indicate informal units, and plain fonts indicate formal units. Versioned charts and detailed information on ratified GSSPs are available at the website <http://www.stratigraphy.org>. The URL to this chart is found below.

Numerical ages are subject to revision and do not define units in the chart. Numerical ages are provided for GSSPs and GSSAs. Numerical ages for GSSPs without ratified GSSPs or without constrained numerical ages, an approximate numerical age (") is provided.

Ratified Subseries/Subepochs are abbreviated as UL (Upper/Late), M (Middle) and LE (Lower/Early). Numerical ages for all systems except Quaternary, upper Paleogene, Cretaceous, Triassic, Permian, Cambrian and Precambrian are taken from "A Geologic Time Scale 2012 by the International Commission on Stratigraphy" (ICS Chronostratigraphic Chart, Edition 30, 198-204), by the relevant ICS subcommissions.

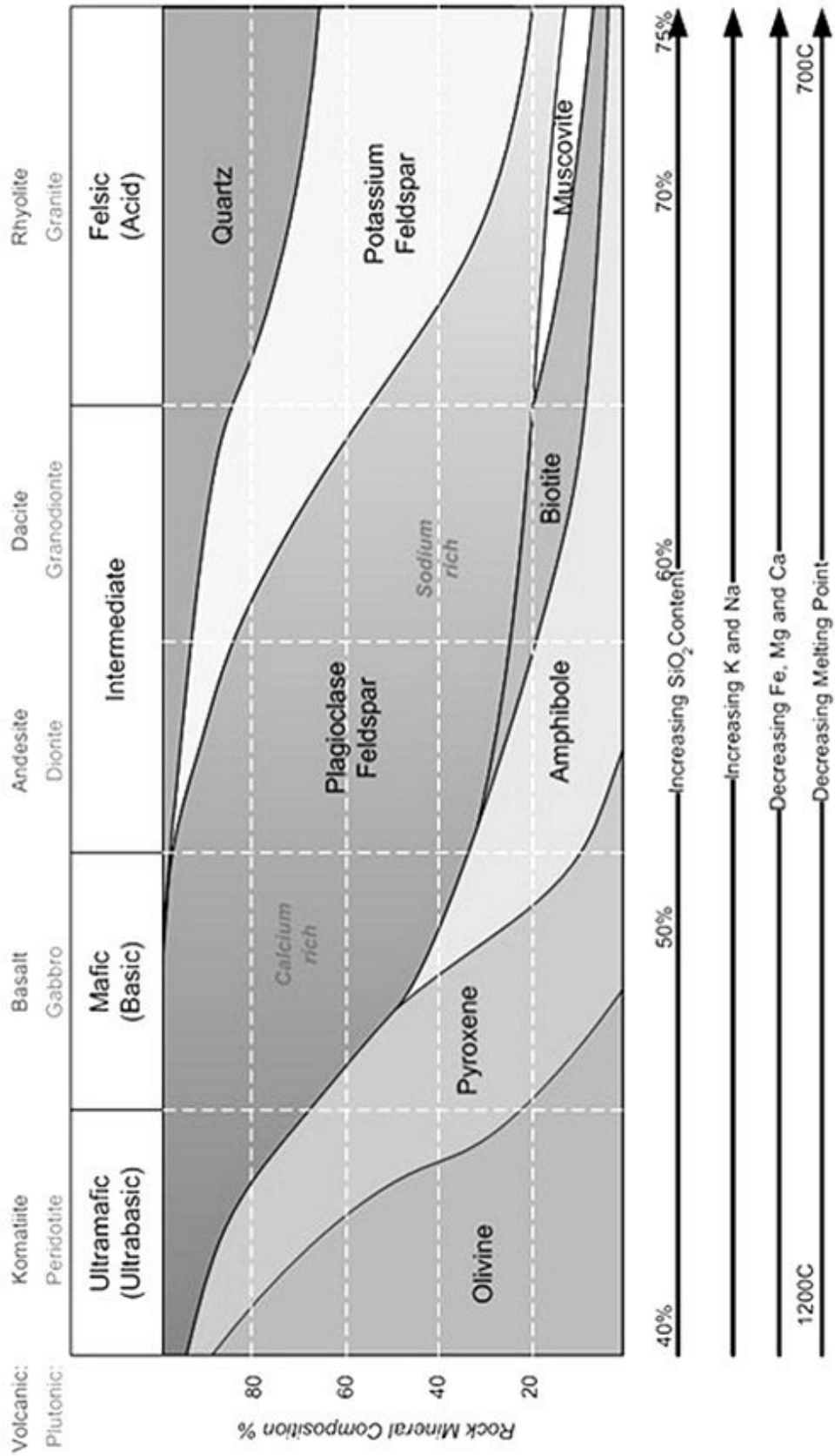
Colouring follows the Commission for the Geological Map of the World (www.cgmw.org)

Chart drafted by K.M. Cohen, D.A.T. Harper, P.L. Gibbard, N. Carr
 (c) International Commission on Stratigraphy, February 2022

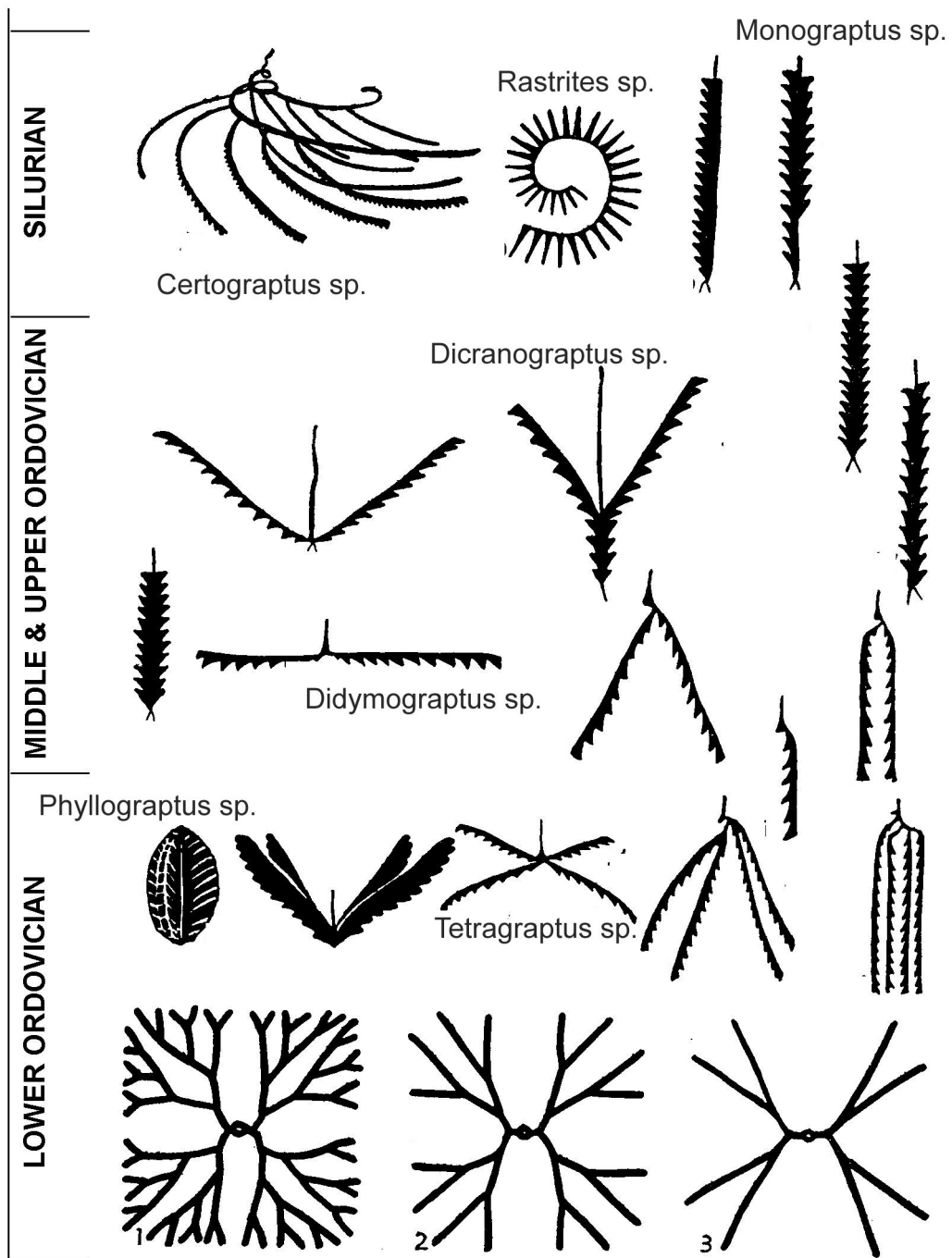
The ICS Chronostratigraphic Chart, Edition 30, 198-204

URL: <http://www.stratigraphy.org/ICSChart/ChronostratChart2022-02.pdf>

International Chronostratigraphic Chart 2022/02 courtesy of
<http://www.stratigraphy.org/index.php/ics-chart-timescale>
 Note: Numerical age (Ma) means the age in millions of years



Igneous rock classification chart



Graptolite shapes through time
 Modified from Moore, Lalicker & Fischer (1952), Figure 22-7

Graptolites through time

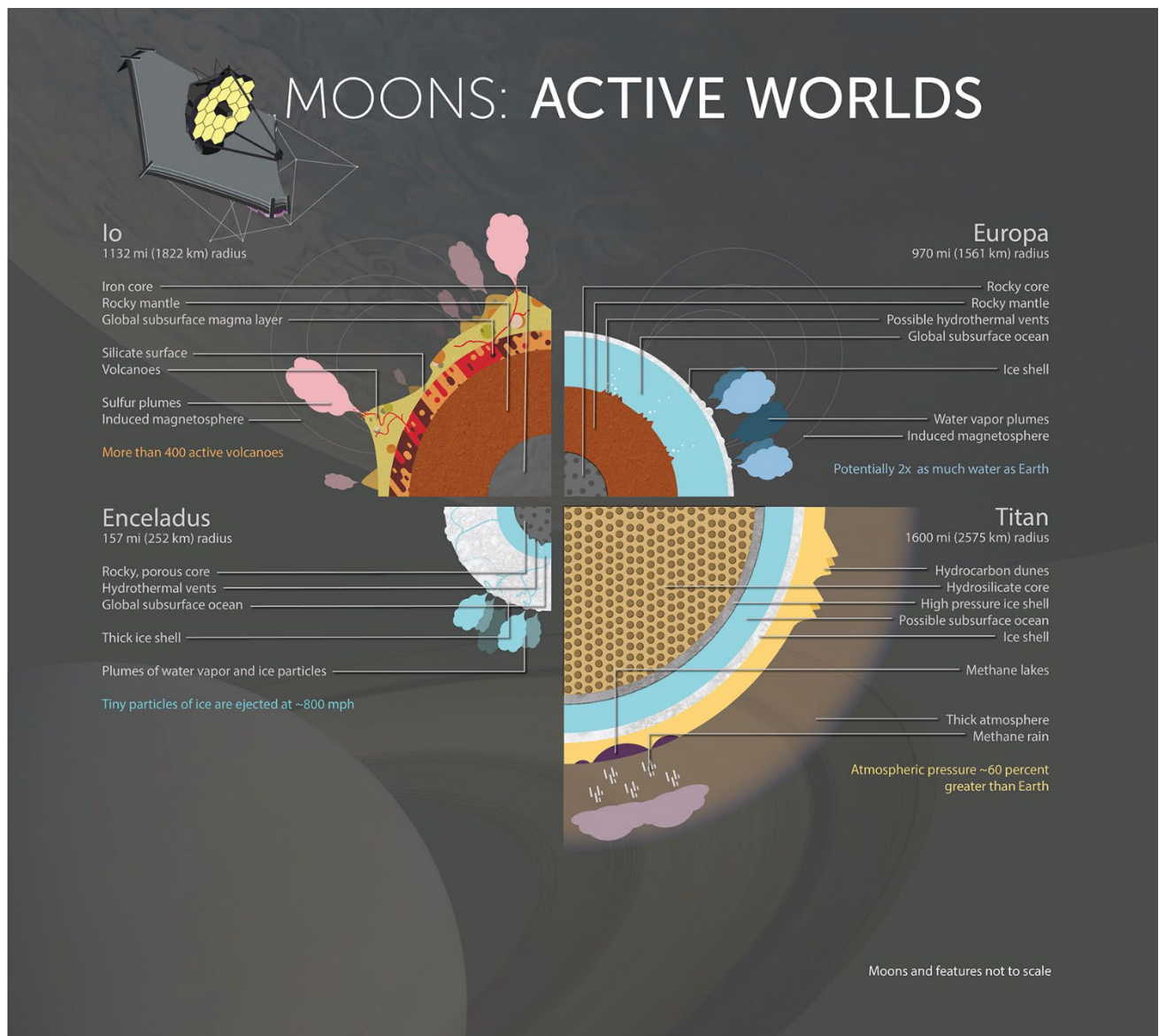
Hardness	Example Minerals/materials
1	Talc
2	Gypsum
2.5	Fingernail, pure gold, silver, aluminium
3	Calcite, copper coin
4	Fluorite
4.5	Platinum, iron
5	Apatite, Pyroxene group (5 to 6)
6	Orthoclase feldspar, titanium, <u>spectrolite</u> , Pyroxene group (5 to 6)
6.5	Plagioclase feldspar, steel file, iron pyrite, glass, vitreous pure silica
7	Quartz, amethyst, <u>citrine</u> , agate, olivine, tridymite (high temp quartz)
7.5	Garnet, <u>coesite</u> (high pressure quartz)
8	Hardened steel, topaz, beryl, emerald, aquamarine
9	Corundum, ruby, sapphire
9.5	Carborundum
10	Diamond

Hardness scale

Location	Surface Temperature	Surface Pressure	Crustal material/s	Atmospheric composition
Earth Surface Gravity (g) 9.81 m/s ²	+70°C (most extreme ever recorded) to -89°C (most extreme ever recorded) (normal global average ~14°C)	1 atm	Dominantly silicates, carbonates, water and ice. Many other mineral classes in minor amounts.	Nitrogen, oxygen, carbon dioxide, water vapour, methane and traces of other natural and anthropogenic gasses.
Europa Surface Gravity 0.134g	-160°C (equator) to -220°C (poles)	~1 x 10 ⁻¹² atm	Water ice	Extremely thin oxygen atmosphere with some water vapour.
Io Surface Gravity 0.183g	-183°C to -143°C (mean is -130°C)	4.93×10 ⁻⁹ to 3.95×10 ⁻⁸ atm	Silicate rock (basaltic), sulphur and sulphur frost.	Extremely thin sulphur dioxide atmosphere with traces of sulphur monoxide, sulphur, sodium chloride and oxygen.
Titan Surface Gravity 0.138g	-179°C on average	1.5 atm	Water ice bedrock plus sand-sized grains of organic molecules forming a surface regolith.	Thick dense atmosphere of methane (95%), ethane (5%) and small amounts of other carbon-rich compounds. Clouds form and it rains liquid methane and ethane that runs off in rivers to lakes.

Useful planetary data

Geologically active moons of the solar system



Jupiter's moons Io and Europa, and Saturn's moons Enceladus and Titan. They show remarkable geological activity for their small size, with features ranging from volcanoes and water plumes to possible subsurface oceans. Image courtesy of NASA (2019).

<https://tinyurl.com/47cu9jfp>