NEUTRON EMISSION FROM FRACTURE AND EARTHQUAKES

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NEUTRON EMISSIONS FROM EARTHQUAKES

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- Kuzhevskij, M., Nechaev, O. Yu. and Sigaeva, E. A., "Distribution of neutrons near the Earth's surface", *Natural Hazards and Earth System Sciences,* **3**: 255-262 (2003).

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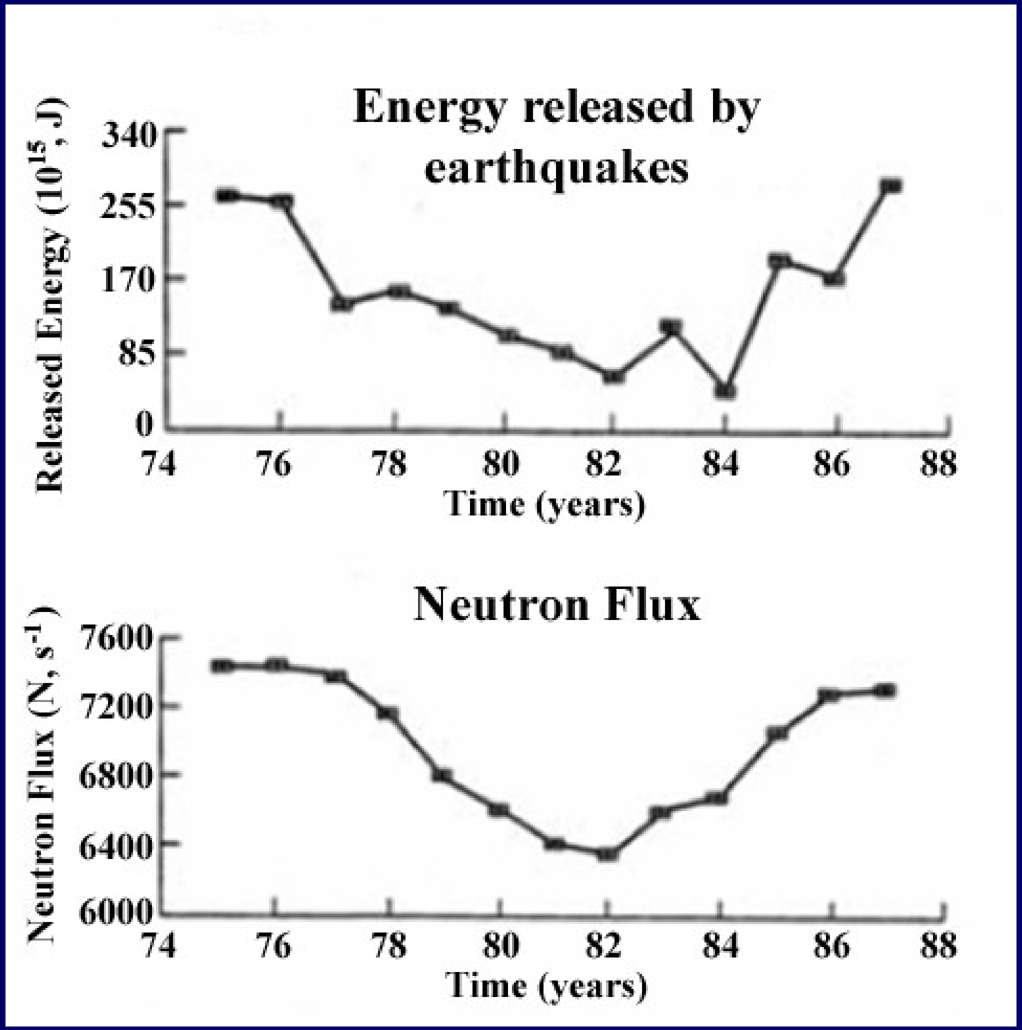
(Continued)

As reported in the literature, an average thermal neutron flux up to 10^0 cm^{-2} s^{-1} **(10^3 times the background level)** was detected in correspondence to earthquakes with a magnitude of the 4th degree in Richter Scale (Volodichev N.N., et al. (1999)).



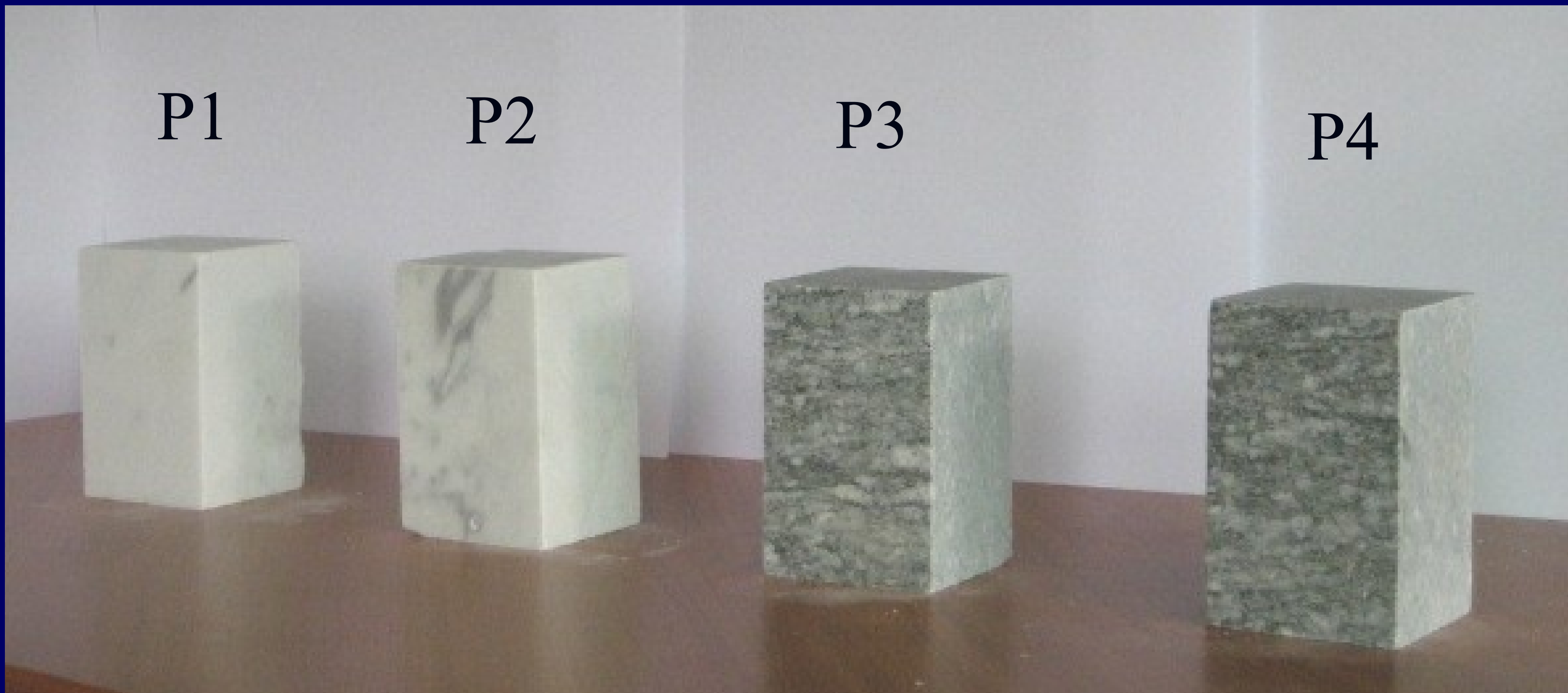
Global seismic activity and neutron flux measurements in the period 1974-1988. Laboratory of Geophysical Precursors, Oblast' Murmansk, Apatity, Kola Peninsula, Russia (Sobolev et al. 1998).

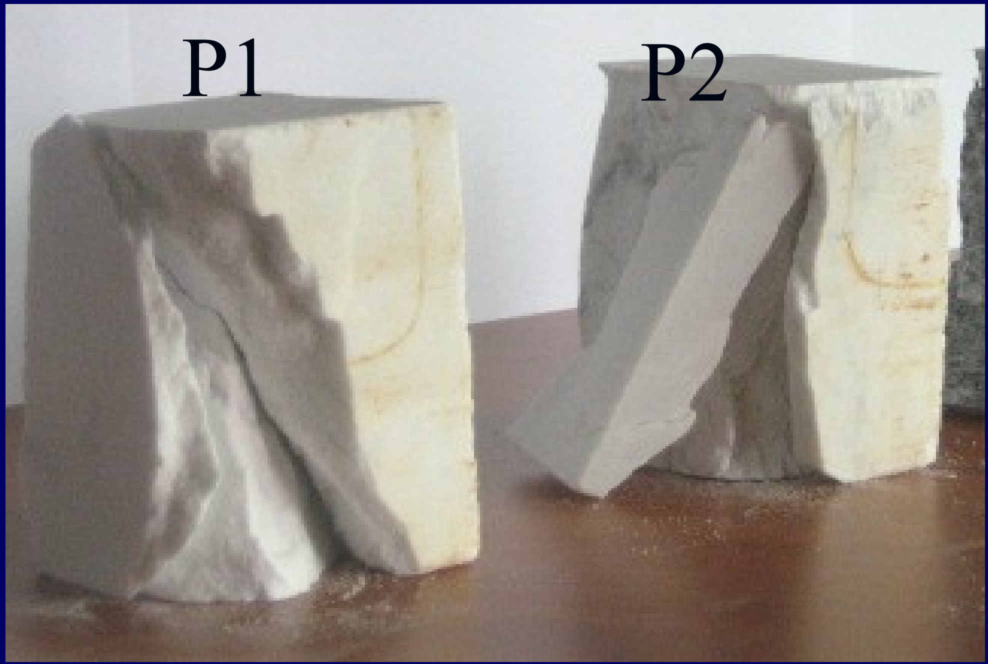
Specimens

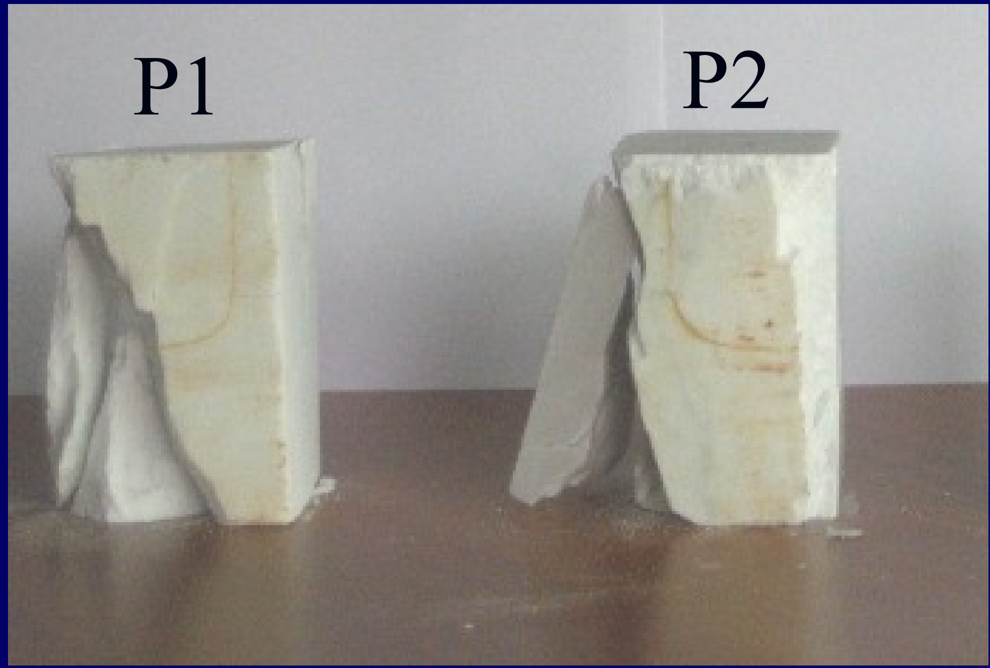
During the experimental analysis <u>four test specimens</u> were used:

- two made of <u>Carrara marble</u>, calcite, specimens P1 and P2;
- two made of <u>Luserna granite</u>, gneiss, specimens P3 and P4;
- all of them measuring 6x6x10 cm^3.

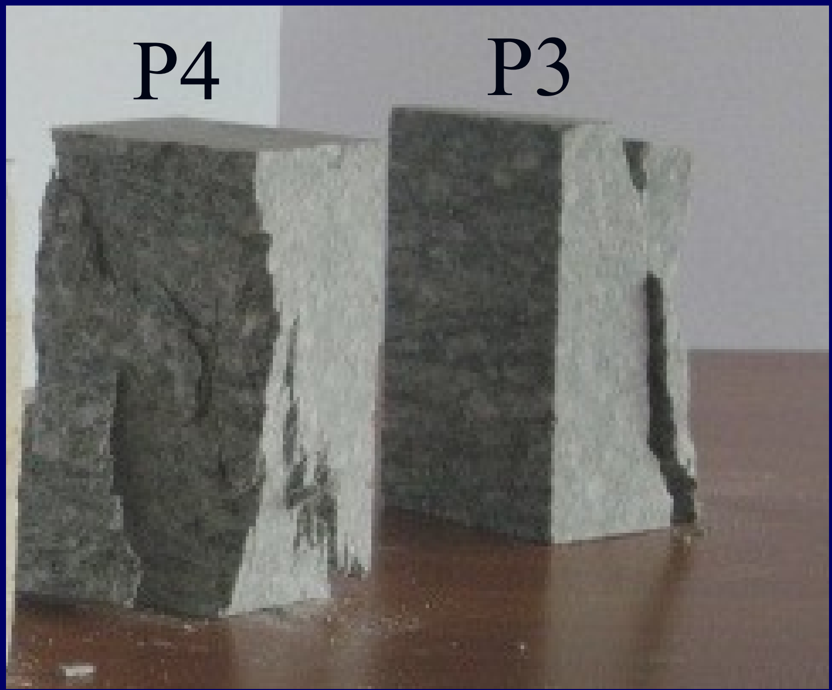
This choice was prompted by the consideration that, test specimen dimensions being the same, different brittleness numbers would cause catastrophic failure in granite, not in marble.

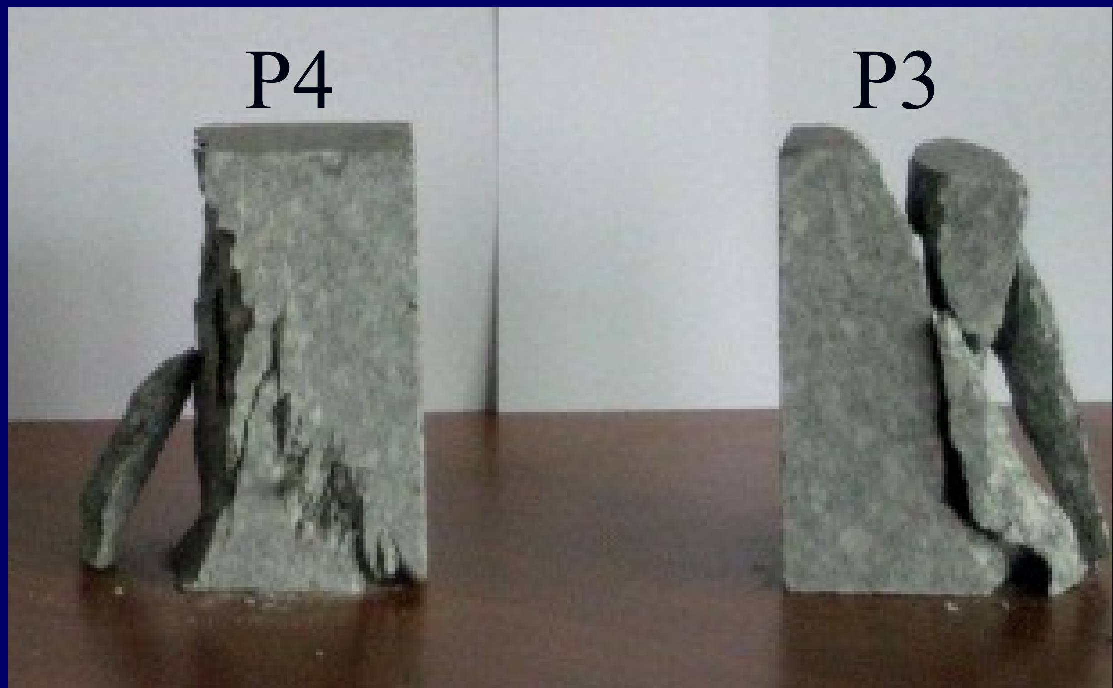






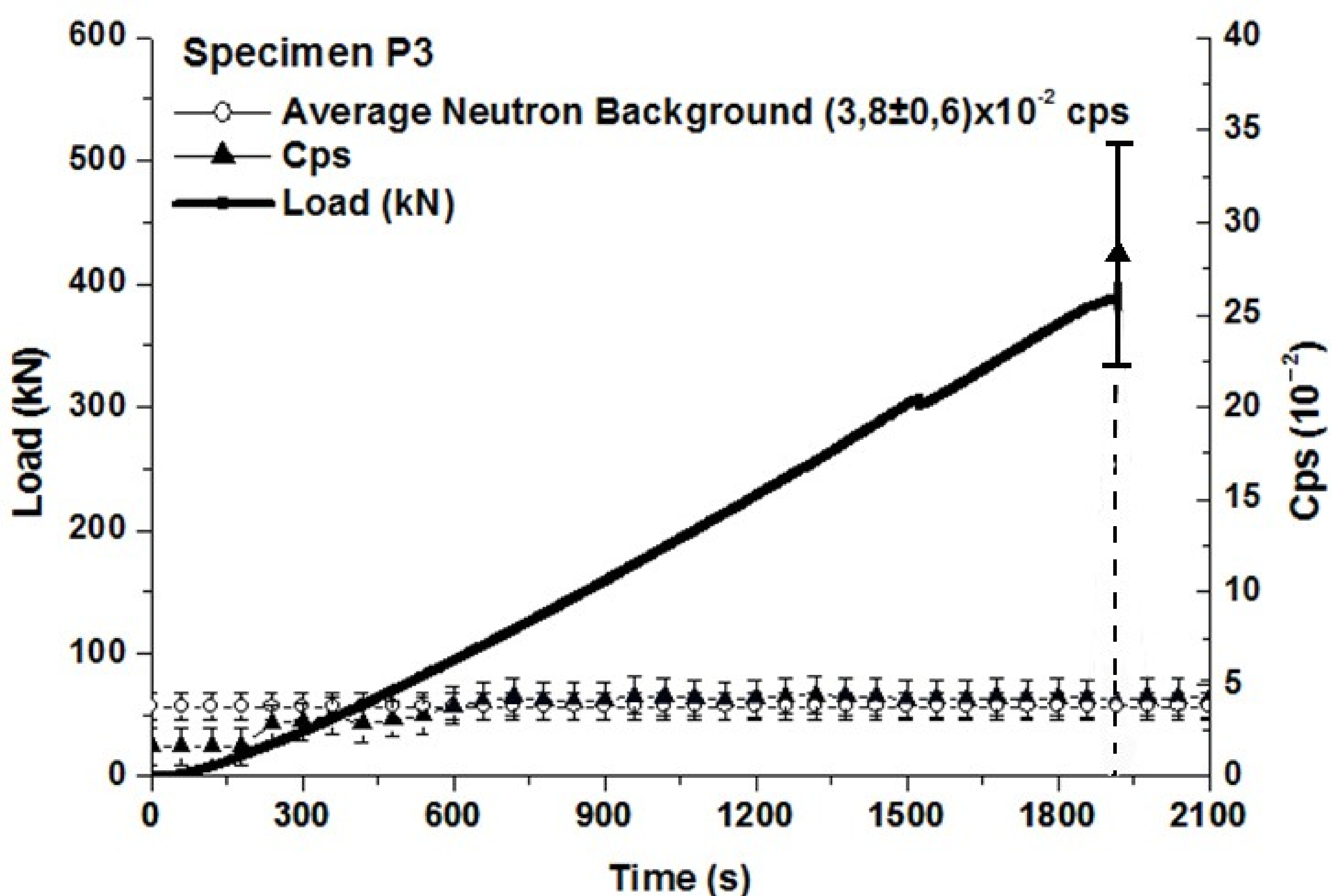
Specimens P1 and P2 in Carrara marble following compression failure.





Specimens P3 e P4 in Luserna granite following compression failure.

Brittle Fracture Experiment on granite specimen



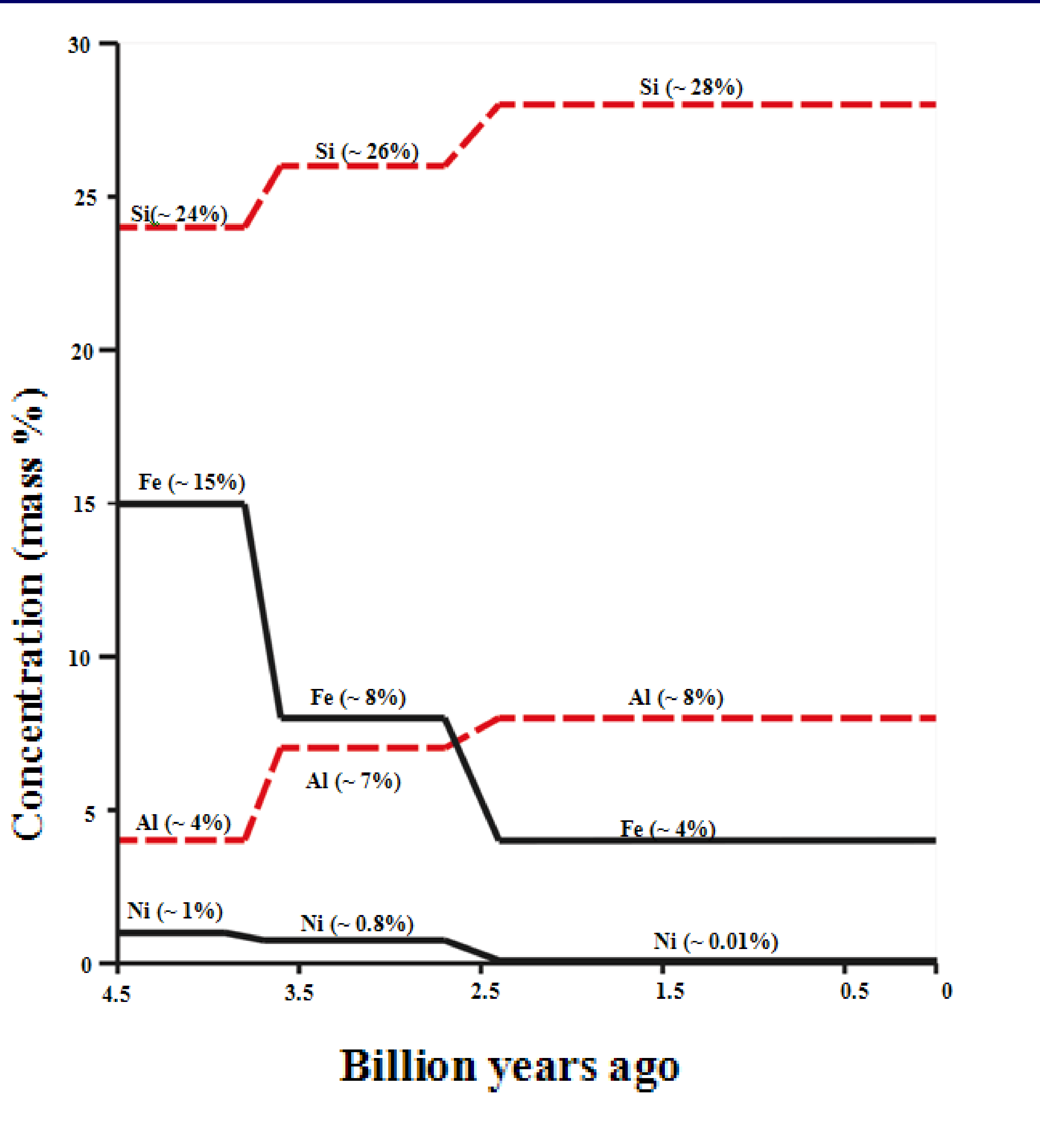
Load vs. time and cps curve for P3 test specimen of granite.

NEUTRON EMISSION FROM CAVITATION OF LIQUIDS AND FRACTURE OF SOLIDS

MATERIAL	NEUTRON EMISSION
LIQUIDS – Cavitation	
Iron chloride	→ up to 2.5 times the Background Level
SOLIDS – Fracture	
Steel	→ up to 2.5 times the Background Level
Granite (Fe ~ 1.5%)	→ up to 10^1 times the Background Level
Basalts (Fe ~ 15%)	→ up to 10^2 times the Background Level
Magnetite (Fe ~ 75%)	→ up to 10^3 times the Background Level
Marble	→ Background Level

IRON DEPLETION
&
CARBON
POLLUTION

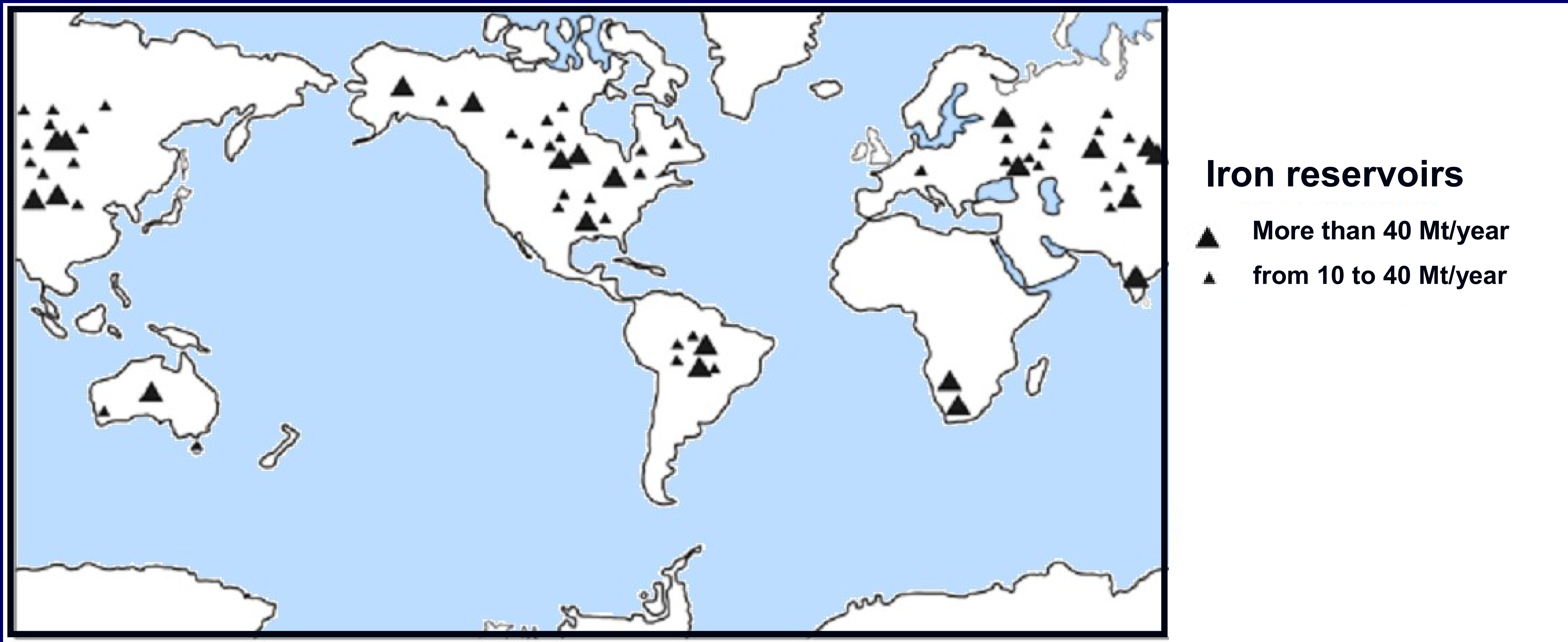
Tectonic plate formation (~3.8×10^9 years ago)



3.8 Billion years ago:
Fe (–7%) + Ni (–0.2%) =
=Al (+3%) + Si (+2.2%) + Mg (+2%)

2.5 Billion years ago:
Fe (–4%) + Ni (–0.8%) =
=Al (+1%) + Si (+2.3%) + Mg (+1.5%)

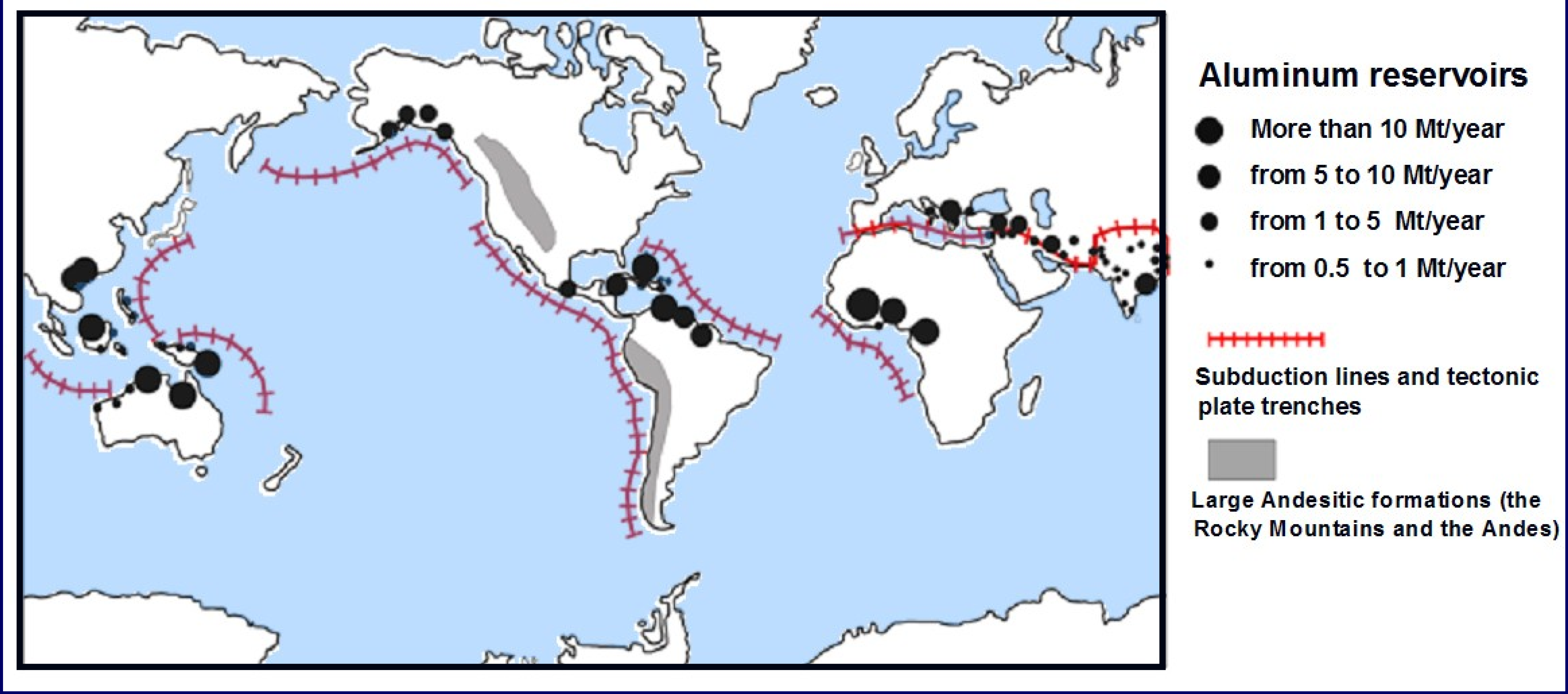
Localization of iron mines



(*) World Iron Ore producers. Available at http://www.mapsofworld.com/minerals/world-iron-ore-producers.html.

(**) World Mineral Resources Map. Available at http://www.mapsofworld.com/world-mineral-map.html.

Localization of Aluminum mines



(*) World Iron Ore producers. Available at http://www.mapsofworld.com/minerals/world-iron-ore-producers.html.

(**) World Mineral Resources Map. Available at http://www.mapsofworld.com/world-mineral-map.html.

Phengite

	External surface mean value (wt%)	Fracture surface mean value (wt%)	Increase/ decrease with respect to phengite	Increase/ decrease with respect to the same element
Fe	6.2	4.0	–2.2%	–35%
Al	12.5	14.5	+2.0%	+16%
Si	28.0	27.8	NO VARIATIONS	NO VARIATIONS
Mg	0.7	0.8	NO VARIATIONS	NO VARIATIONS
K	8.0	7.7	NO VARIATIONS	NO VARIATIONS

The results of these quantitative analysis represent a direct evidence that piezonuclear reaction

$$\mathrm{Fe}_{26}^{56} \rightarrow 2\,\mathrm{Al}_{13}^{27} + 2 \text{ neutrons}$$

has occurred in the rock specimens.

Biotite

	External surface mean value (wt%)	Fracture surface mean value (wt%)	Increase/ decrease with respect to biotite	Increase/ decrease with respect to the same element
Fe	21.2	18.2	–3.0 %	–14%
Al	8.1	9.6	+1.5 %	+18%
Si	18.4	19.6	+1.2 %	+6%
Mg	1.5	2.2	+0.7 %	+46%
K	6.9	7.1	NO VARIATIONS	NO VARIATIONS

Therefore, the Fe decrease (–3.0%) in biotite is counterbalanced by an increase in Al (+1.5%), Si (+1.2%), and Mg (+0.7%). Considering these evidences, in analogy to the previous results, it is possible to conjecture that another piezonuclear reaction has been occurred in the biotite crystalline phase during the tests:

$$Fe^{56}_{26} \rightarrow Si^{28}_{14} + Mg^{24}_{12} + 4 \text{ neutrons}$$

Olivine

	External surface mean value (wt%)	Fracture surface mean value (wt%)	Increase/decrease with respect to Olivine	Increase/decrease with respect to the same element
Fe	18.4	14.4	–4.0%	–21%
Si	18.3	20.5	+2.2%	+12%
Mg	21.2	22.8	+1.6%	+7%
Ca	0.5	0.5	NO VARIATIONS	NO VARIATIONS

Therefore, the Fe decrease (–4.0%) in olivine is counterbalanced by an increase in Si (+2.2%) and Mg (+1.6%). Considering these evidences, in analogy to the previous results, the following piezonuclear reaction is conjectured :

$$Fe_{26}^{56} \rightarrow Si_{14}^{28} + Mg_{12}^{24} + 4 \ \text{neutrons}$$

Magnetite

	External surface mean value (wt%)	Fracture surface mean value (wt%)	Increase/decrease with respect to Magnetite	Increase/decrease with respect to the same element
Fe	64.8	36.8	–28.0%	+56%
Al	–	10.1	+10.1%	BEFORE ABSENT
Mn	–	2.2	+2.2%	BEFORE ABSENT
Si	1.6	10.3	+8.7%	+540%
O	31.8	38.5	+6.7%	+21%

The Fe decrease (–28.0%) in magnetite is counterbalanced by an increase in Al (+10.1%), Mn (+2.2%), Si (+8.7%) and O (+6.7%). Considering these evidences, in analogy to the previous results, the following piezonuclear reactions are conjectured:

$$Fe_{26}^{56} \rightarrow 2\,Al_{13}^{27} + 2 \text{ neutrons}$$

$$Fe_{26}^{56} \rightarrow Mn_{25}^{55} + H_{1}^{1}$$

$$Fe_{26}^{56} \rightarrow Si_{14}^{28} + O_{8}^{16} + 2He_{2}^{4} + 4 \text{ neutrons}$$

Marble

	External surface mean value (wt%)	Fracture surface mean value (wt%)	Increase/ decrease with respect to Carrara Marble	Increase/ decrease with respect to the same element
Ca	13.4	9.8	–3.6 %	–26%
Mg	0.7	0.3	–0.4 %	–57%
O	45.8	36.8	–9.0 %	–19%
C	40.1	53.1	+13.0%	+32%

The Ca, Mg and O decreases (–3.6%), (–0.4%) and (–9.0%) in marble are counterbalanced by an increase in C (+13.0%). It is possible to conjecture that the following piezonuclear reactions have been occurred:

$$Mg_{12}^{24} \rightarrow 2C_{6}^{12}$$

$$Ca_{20}^{40} \rightarrow 3C_{6}^{12} + He_{2}^{4}$$

$$O_{8}^{16} \rightarrow C_{6}^{12} + He_{2}^{4}$$

Magnesium depletion in the Earth Crust and Carbon concentration in the primordial atmosphere

The assumed virtual Mg increase (~3.5%) can be confirmed by the Carbon content in the primordial atmosphere:

$$Fe_{26}^{56} \rightarrow Mg_{12}^{24} + Si_{14}^{28} + 4 \text{ neutrons}$$
$$Mg_{12}^{24} \rightarrow 2C_{6}^{12}$$

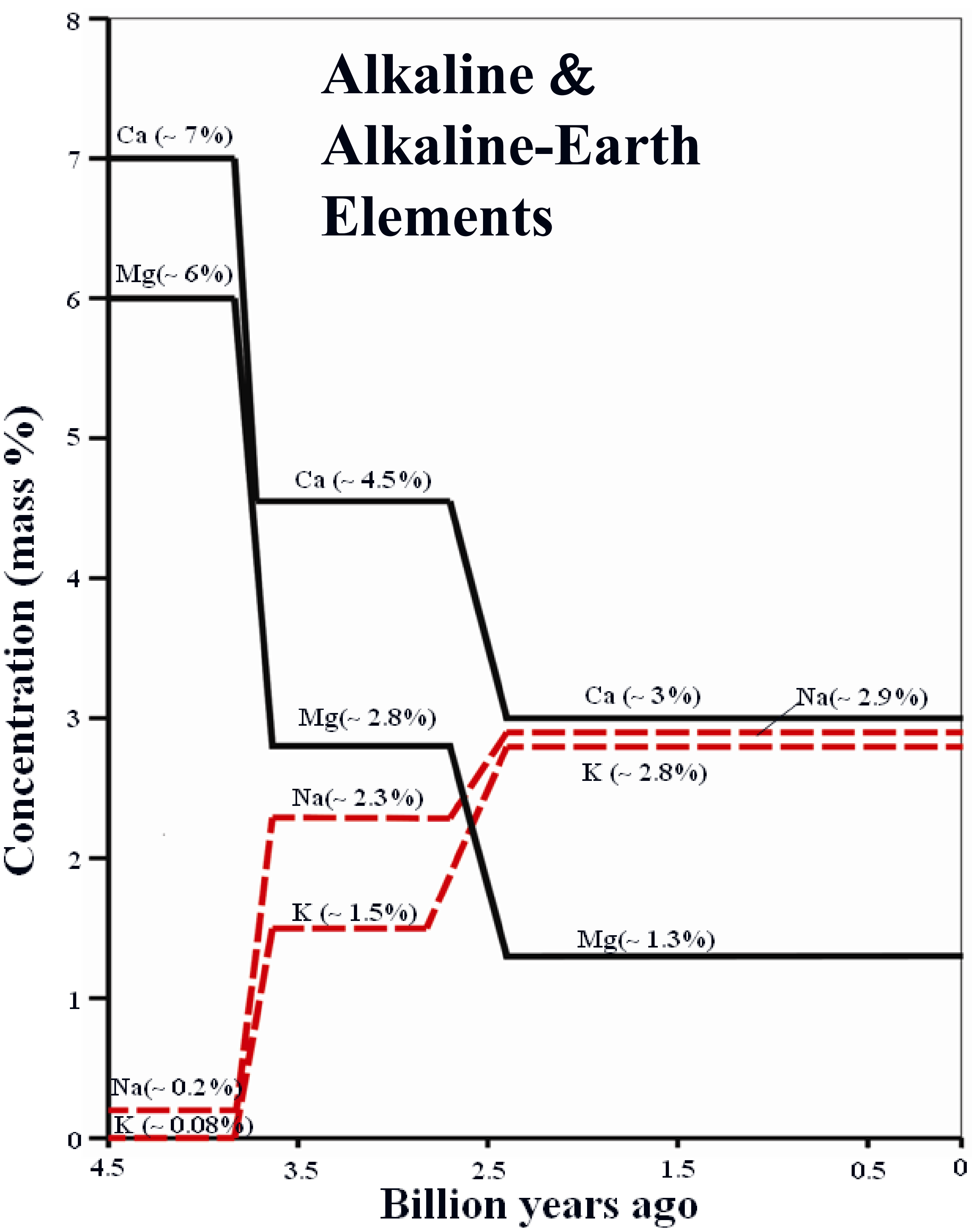
Assuming a mean density of the Earth Crust equal to 3.6 g/cm^3 and a thickness of ~60 km, the mass increase in Mg (~3.5×10^{21} kg) implies a very high atmospheric pressure due to the transformed carbon.

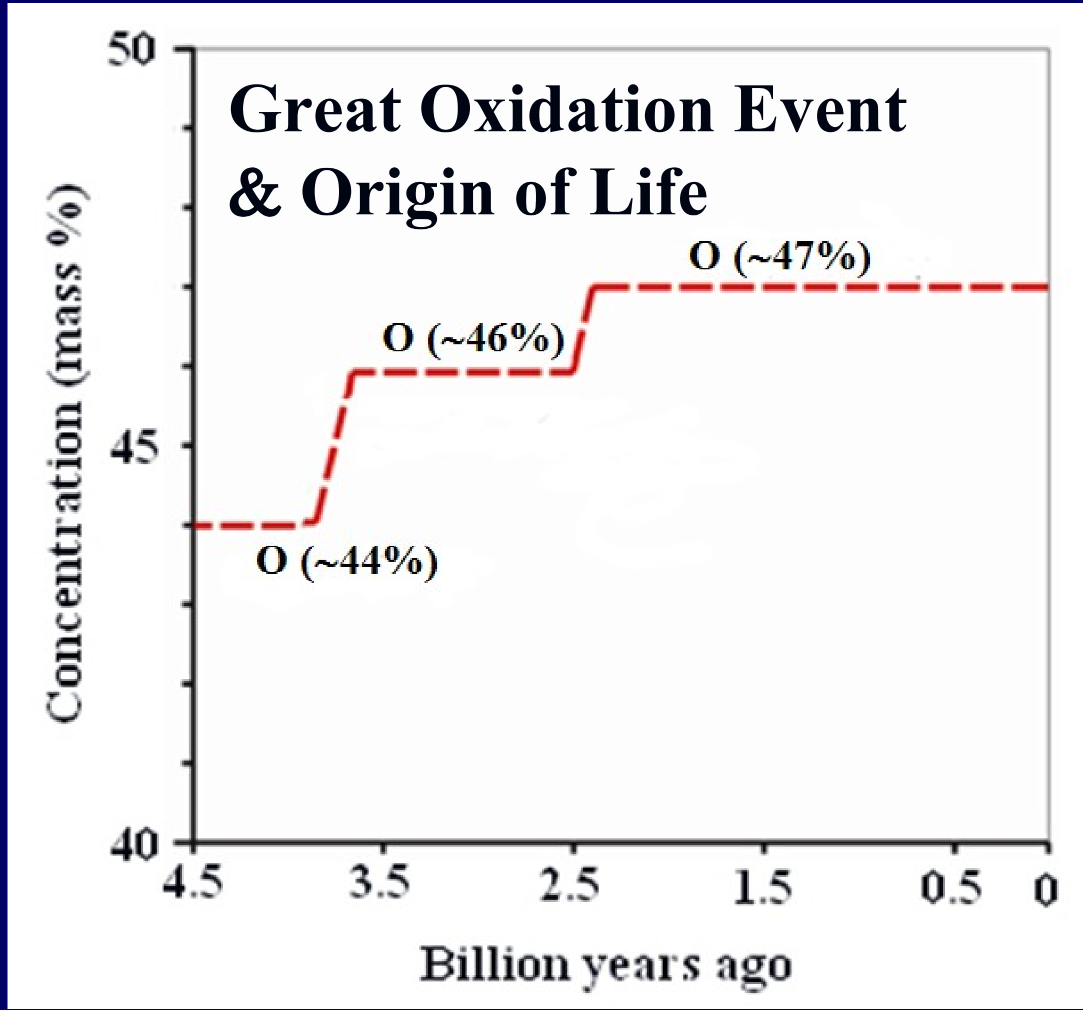
Primordial atmospheric pressure due to piezonuclear C content = ~650 atm

Primordial atmospheric pressure reported by other authors = ~650 atm (Liu, 2004)

Liu, L., "The inception of the oceans and CO_2-atmosphere in the early history of the Earth". *Earth Planet. Sci. Lett.*, 227, 179–184 (2004)

CALCIUM DEPLETION & OCEAN FORMATION





3.8 Billion years ago:
Ca (–2.5%) + Mg(–3.2%) =
= K (+1.4%) + Na (+2.1%) + O (+2.2%)

2.5 Billion years ago:
Ca (–1.5%) + Mg(–1.5%) =
=K (+1.3%) + Na (+0.6%) + O (+1.1%)

Calcium depletion in the Earth Crust and ocean formation

Global decrease in Ca (–4.0%) is counterbalanced by an increase in K (+2.7%) and in H_2O (+1.3%).

$$Ca_{20}^{40} \rightarrow K_{19}^{39} + H_1^1$$

$$Ca_{20}^{40} \rightarrow 2O_8^{16} + 4H_1^1 + 4 \text{ neutrons}$$

Considering a mean density of the Earth Crust equal to 3.6 g/cm^3 and an average thickness of ~60 km, the partial mass decrease in Ca is about 1.41 $\times 10^{21}$ kg.

Considering a global ocean surface of 3.607 $\times 10^{14}$ m^2, and an average depth of 3950 m, we obtain a mass of water of about 1.35 $\times 10^{21}$ kg.

Partial decrease in Ca 1.41 $\times 10^{21}$ kg

Mass of H_2O in the oceans today 1.35 $\times 10^{21}$ kg