

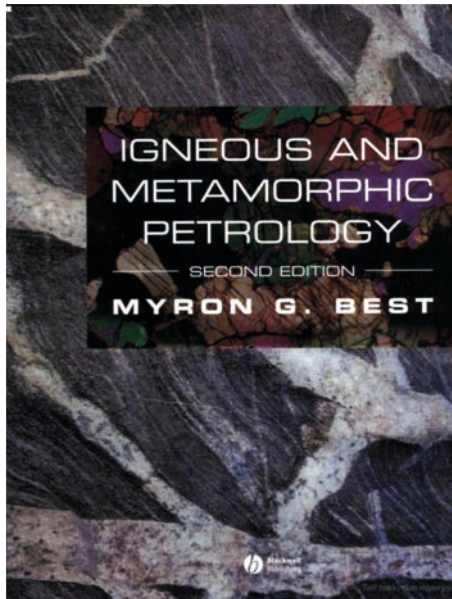
# Corso di Geologia del Cristallino 2019/2020

Docente: Dr. Luca Ziberna

Email: [luca.ziberna@units.it](mailto:luca.ziberna@units.it)

Palazzina N, Via Weiss 8, 34128, Trieste

Tel. ufficio: 0405582221



Libro di testo principale usato come riferimento:

Best, M.G. (2003). Igneous and Metamorphic

Petrology. 2<sup>nd</sup> ed. Blackwell Publishing. 729 pp.

# Introduzione

Questo corso ha come scopo quello di fornire delle conoscenze utili al geologo che deve lavorare su terreni magmatici (e metamorfici).

Uno studio geologico di un certo complesso magmatico e/o metamorfico si può dividere in due parti principali:

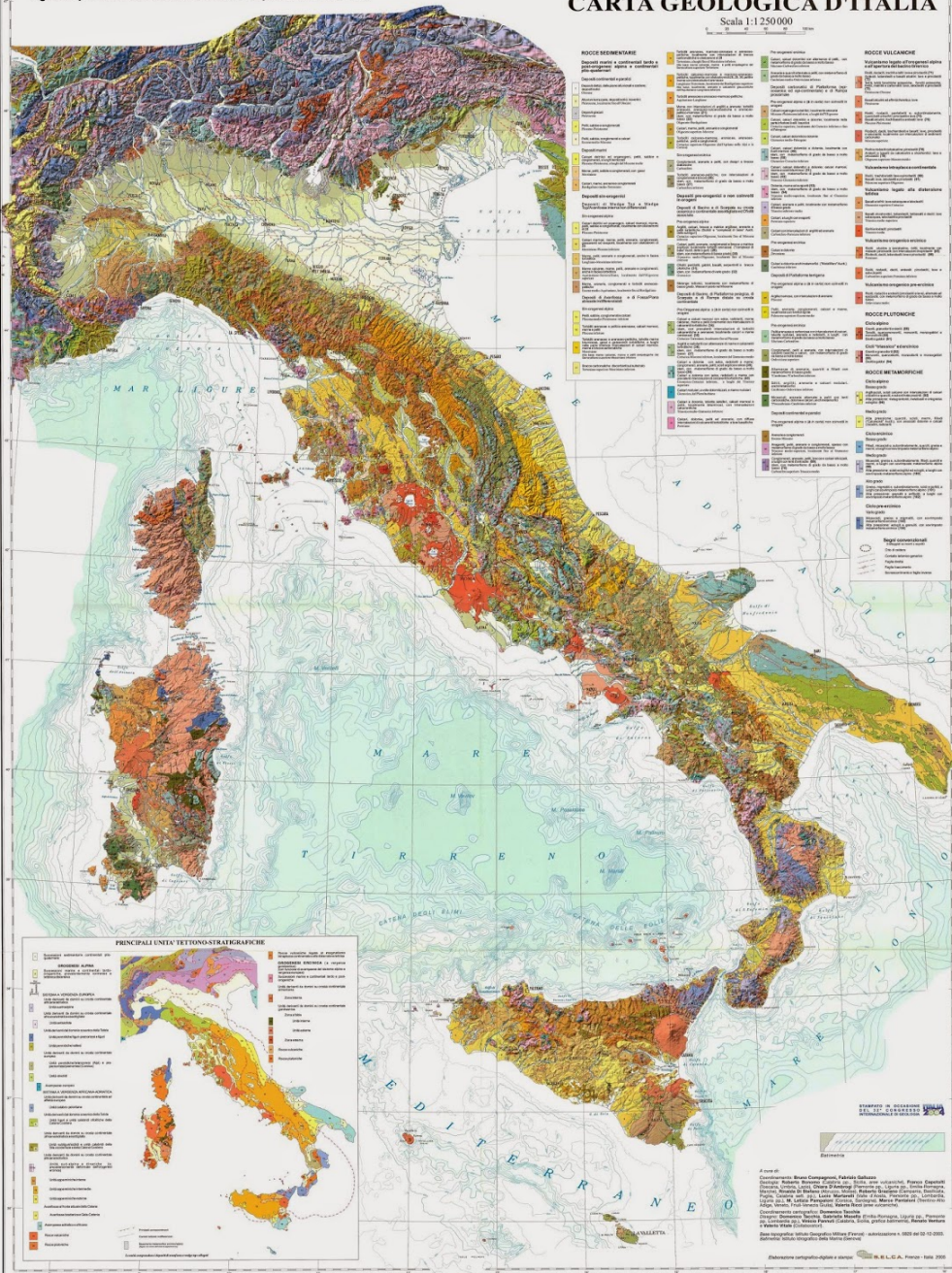
- Descrizione e caratterizzazione del complesso (osservazioni di campagna, petrografia, geochimica, etc)
- Interpretazione dei processi geologici che hanno formato quel complesso

# Introduzione

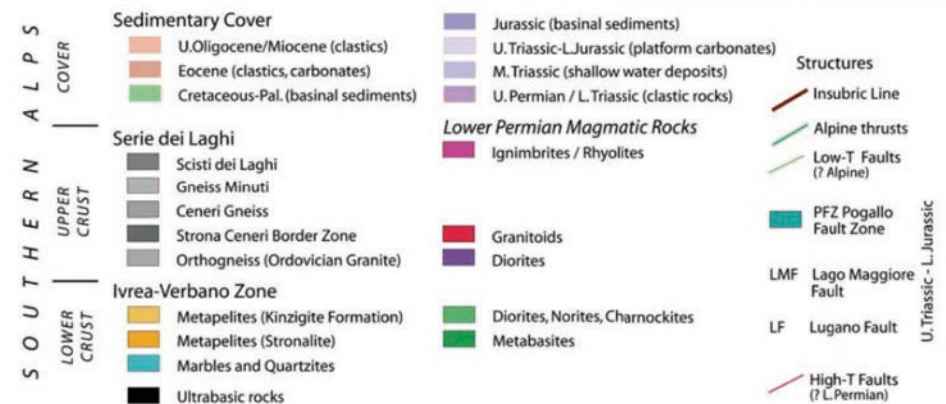
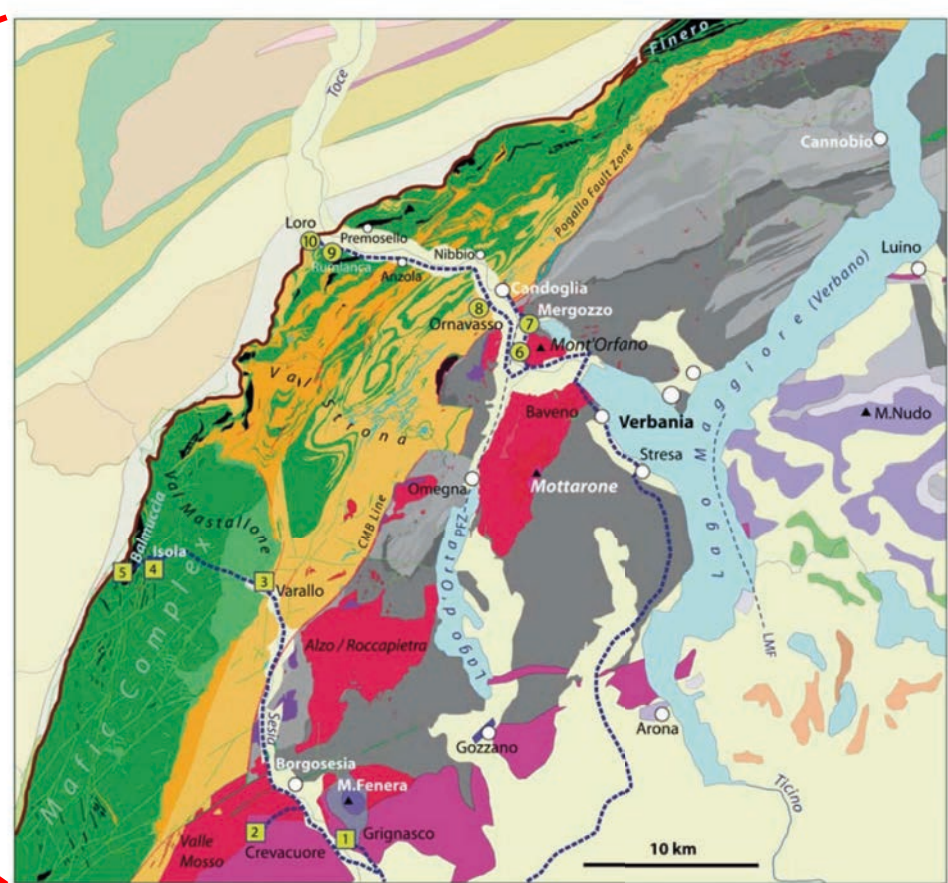
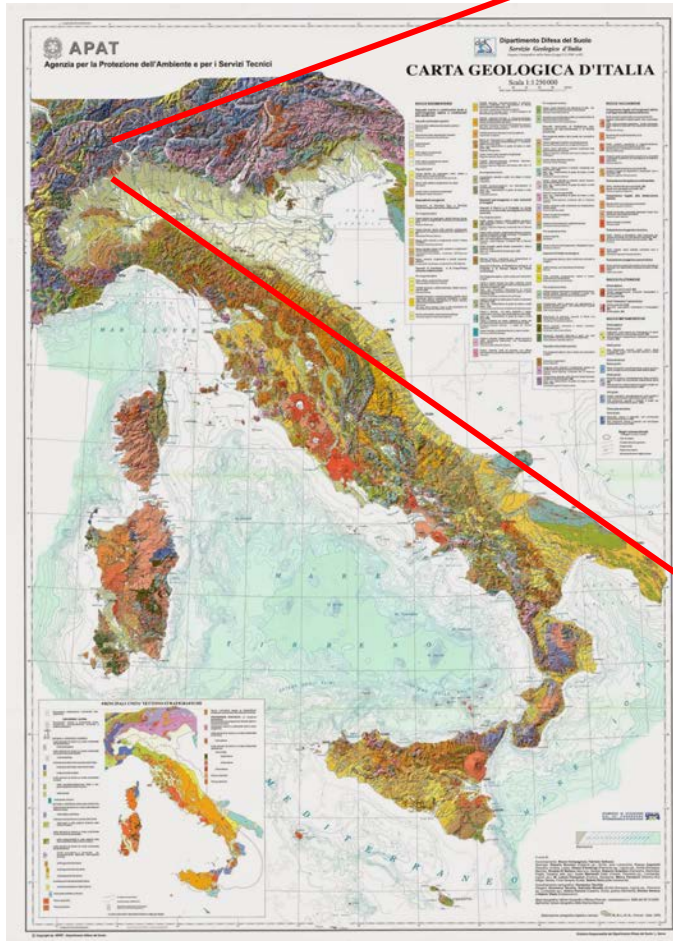
Perché è importante lo studio dei complessi magmatici e metamorfici?

# CARTA GEOLOGICA D'ITALIA

Scala 1:1250000

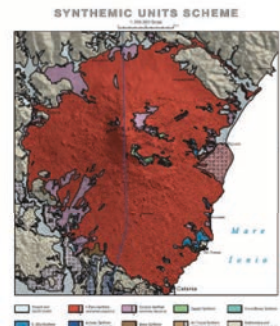
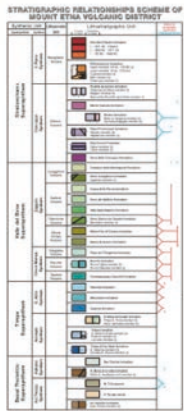
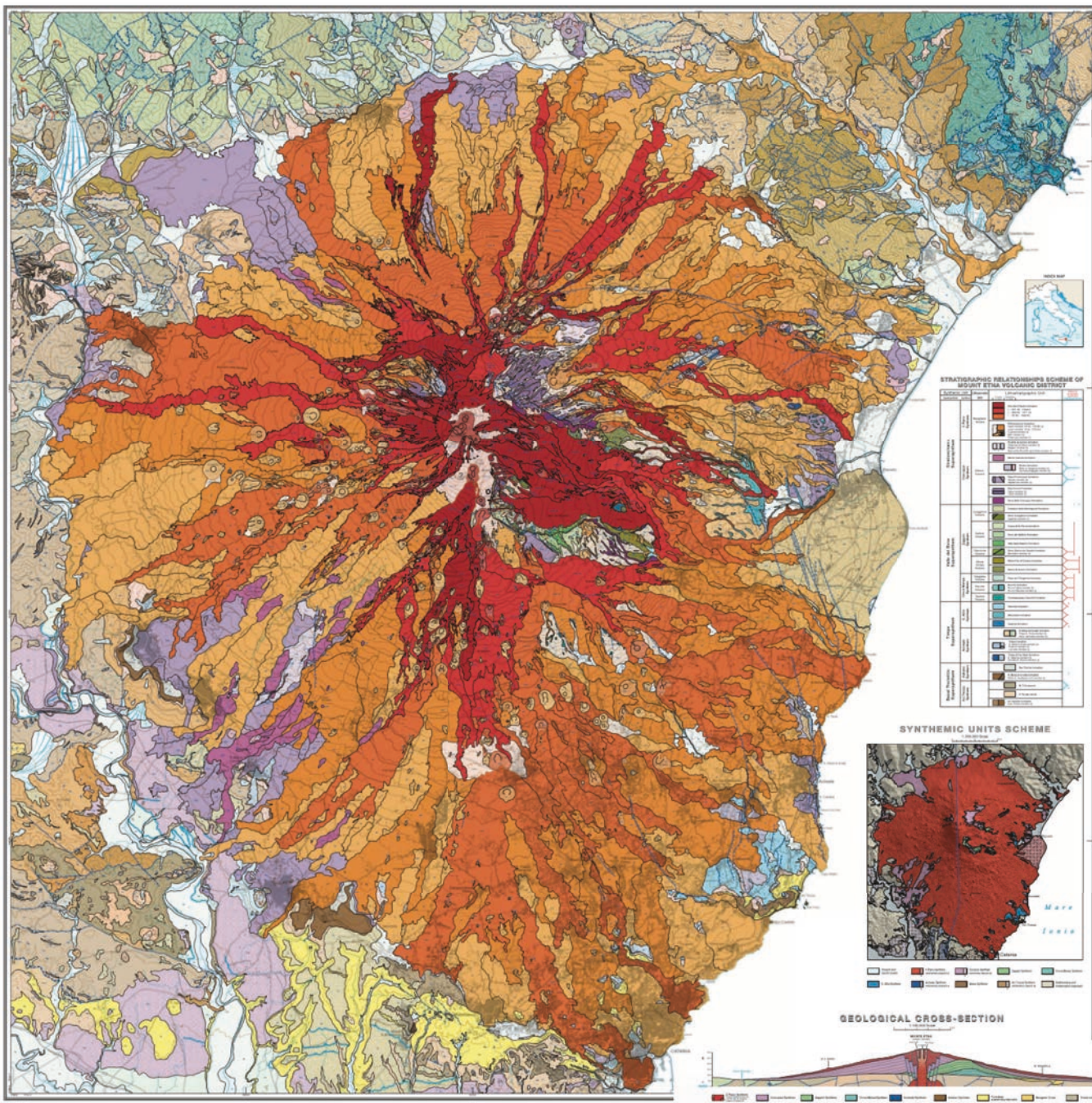


...per la caratterizzazione del territorio



Brack et al. (2010; Swiss Bull.)

**Fig. 3:** Geological map of the Massiccio dei Laghi west of Lago Maggiore [Ivrea-Verbano Zone and Serie dei Laghi; simplified after a compilation by T. James 2001]. The proposed field trip itineraries and stops are indicated: crustal section and mantle rocks in Valsesia (squares), upper and lower crustal rocks in Val d'Ossola (circles).

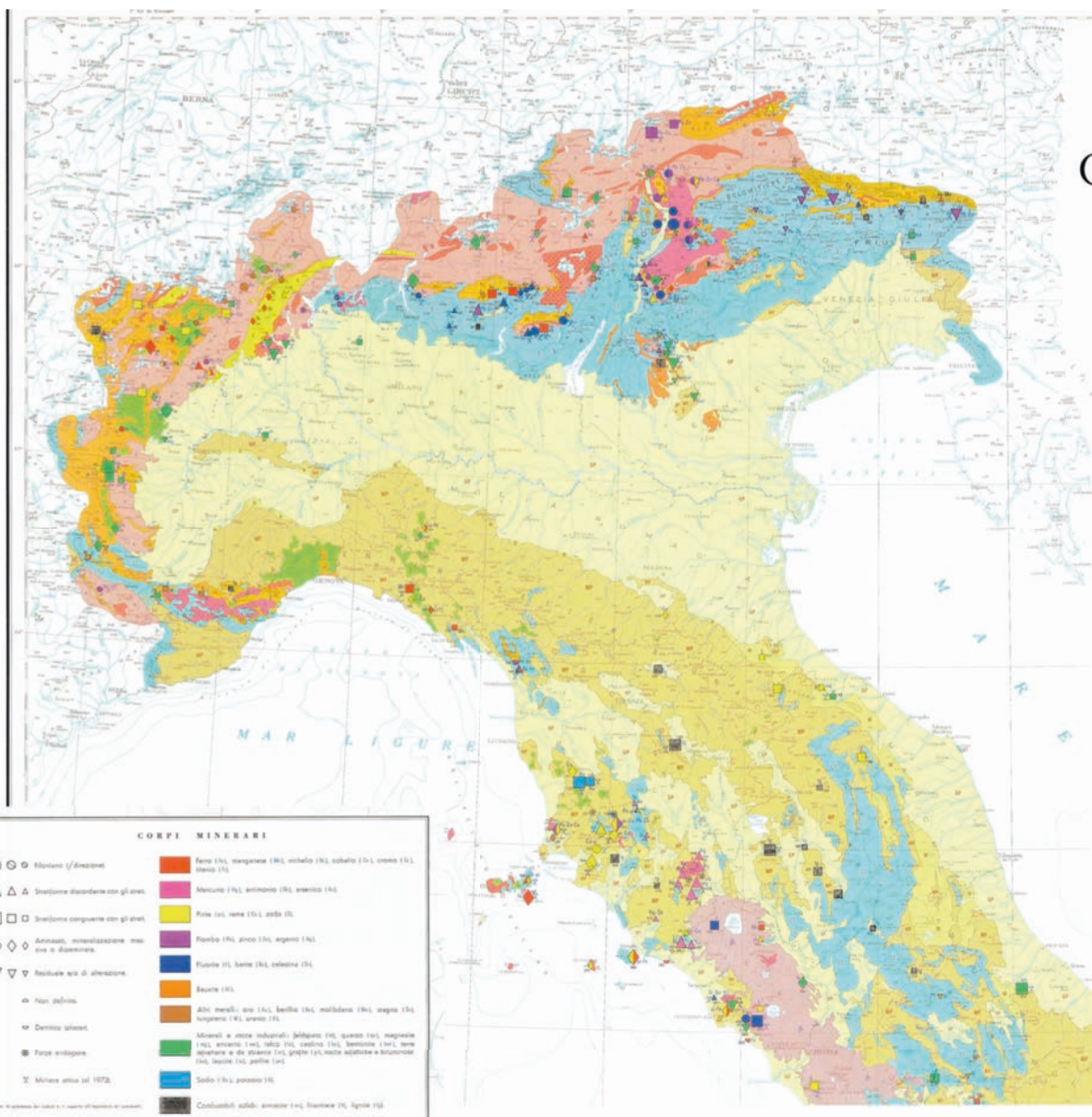


UNIT	SYMBOL	DESCRIPTION
1	[Symbol]	Quaternary deposits
2	[Symbol]	Recent volcanic products
3	[Symbol]	Recent volcanic products
4	[Symbol]	Recent volcanic products
5	[Symbol]	Recent volcanic products
6	[Symbol]	Recent volcanic products
7	[Symbol]	Recent volcanic products
8	[Symbol]	Recent volcanic products
9	[Symbol]	Recent volcanic products
10	[Symbol]	Recent volcanic products
11	[Symbol]	Recent volcanic products
12	[Symbol]	Recent volcanic products
13	[Symbol]	Recent volcanic products
14	[Symbol]	Recent volcanic products
15	[Symbol]	Recent volcanic products
16	[Symbol]	Recent volcanic products
17	[Symbol]	Recent volcanic products
18	[Symbol]	Recent volcanic products
19	[Symbol]	Recent volcanic products
20	[Symbol]	Recent volcanic products
21	[Symbol]	Recent volcanic products
22	[Symbol]	Recent volcanic products
23	[Symbol]	Recent volcanic products
24	[Symbol]	Recent volcanic products
25	[Symbol]	Recent volcanic products
26	[Symbol]	Recent volcanic products
27	[Symbol]	Recent volcanic products
28	[Symbol]	Recent volcanic products
29	[Symbol]	Recent volcanic products
30	[Symbol]	Recent volcanic products
31	[Symbol]	Recent volcanic products
32	[Symbol]	Recent volcanic products
33	[Symbol]	Recent volcanic products
34	[Symbol]	Recent volcanic products
35	[Symbol]	Recent volcanic products
36	[Symbol]	Recent volcanic products
37	[Symbol]	Recent volcanic products
38	[Symbol]	Recent volcanic products
39	[Symbol]	Recent volcanic products
40	[Symbol]	Recent volcanic products
41	[Symbol]	Recent volcanic products
42	[Symbol]	Recent volcanic products
43	[Symbol]	Recent volcanic products
44	[Symbol]	Recent volcanic products
45	[Symbol]	Recent volcanic products
46	[Symbol]	Recent volcanic products
47	[Symbol]	Recent volcanic products
48	[Symbol]	Recent volcanic products
49	[Symbol]	Recent volcanic products
50	[Symbol]	Recent volcanic products
51	[Symbol]	Recent volcanic products
52	[Symbol]	Recent volcanic products
53	[Symbol]	Recent volcanic products
54	[Symbol]	Recent volcanic products
55	[Symbol]	Recent volcanic products
56	[Symbol]	Recent volcanic products
57	[Symbol]	Recent volcanic products
58	[Symbol]	Recent volcanic products
59	[Symbol]	Recent volcanic products
60	[Symbol]	Recent volcanic products
61	[Symbol]	Recent volcanic products
62	[Symbol]	Recent volcanic products
63	[Symbol]	Recent volcanic products
64	[Symbol]	Recent volcanic products
65	[Symbol]	Recent volcanic products
66	[Symbol]	Recent volcanic products
67	[Symbol]	Recent volcanic products
68	[Symbol]	Recent volcanic products
69	[Symbol]	Recent volcanic products
70	[Symbol]	Recent volcanic products
71	[Symbol]	Recent volcanic products
72	[Symbol]	Recent volcanic products
73	[Symbol]	Recent volcanic products
74	[Symbol]	Recent volcanic products
75	[Symbol]	Recent volcanic products
76	[Symbol]	Recent volcanic products
77	[Symbol]	Recent volcanic products
78	[Symbol]	Recent volcanic products
79	[Symbol]	Recent volcanic products
80	[Symbol]	Recent volcanic products
81	[Symbol]	Recent volcanic products
82	[Symbol]	Recent volcanic products
83	[Symbol]	Recent volcanic products
84	[Symbol]	Recent volcanic products
85	[Symbol]	Recent volcanic products
86	[Symbol]	Recent volcanic products
87	[Symbol]	Recent volcanic products
88	[Symbol]	Recent volcanic products
89	[Symbol]	Recent volcanic products
90	[Symbol]	Recent volcanic products
91	[Symbol]	Recent volcanic products
92	[Symbol]	Recent volcanic products
93	[Symbol]	Recent volcanic products
94	[Symbol]	Recent volcanic products
95	[Symbol]	Recent volcanic products
96	[Symbol]	Recent volcanic products
97	[Symbol]	Recent volcanic products
98	[Symbol]	Recent volcanic products
99	[Symbol]	Recent volcanic products
100	[Symbol]	Recent volcanic products



Notes and additional information regarding the map, including scale, projection, and data sources.

...per la prospezione delle georisorse minerarie



  
**SERVIZIO GEOLOGICO D'ITALIA**  
ORGANO CARTOGRAFICO DELLO STATO  
**CARTA MINERARIA D'ITALIA**  
 Scala 1:1.000.000  
 ROMA 1973

**COLLABORATORI:** Istituti Minerali della Direzione Generale delle Miniere, Regioni, Enti Minerali Regionali, A. Fioravanti, L. Bizio, C. Biondi, C. Canadò, G. Deiana, F. D. De Colombara, A. Fandani, P. Natali, P. Orsattini, G. Perini, F. Pigo, S. Riva, I. Sabatini, G. Stampone, L. Vighi, S. Zucchetti, P. Zuffanti.  
**COORDINATORE:** C. Stampone.  
**DIREGNO E CARTOGRAFIA:** E. Cassi, M. Gasi, A. Jasi.  
**DIRETTORE DEL SERVIZIO GEOLOGICO:** A. Jankovits.

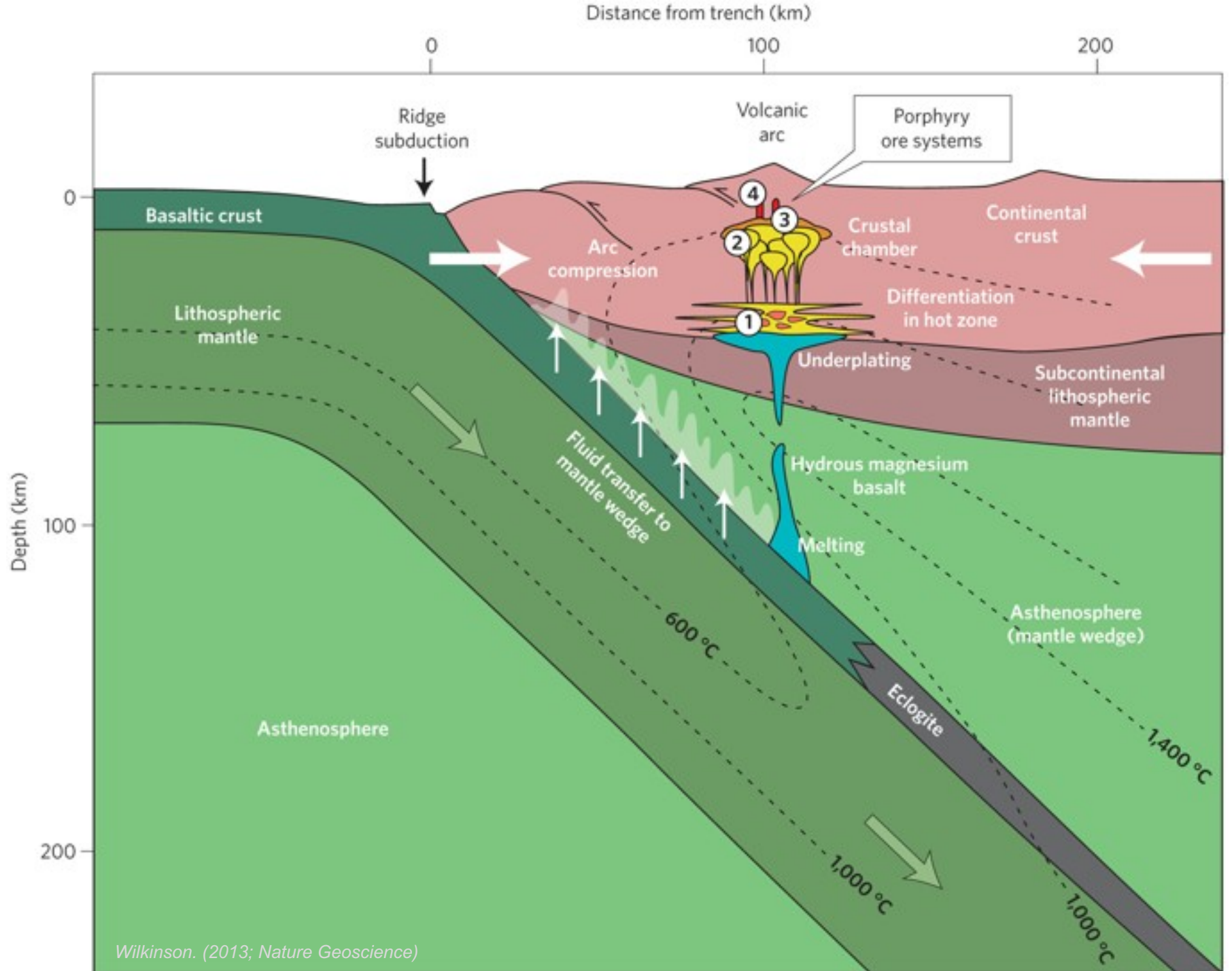
Pubblicata con il finanziamento dell'E.G.A.M.

<p><b>ROCCE SEDIMENTARIE</b></p> <p><b>CRETACEO-QUATERNARIO</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffcc; border: 1px solid black; margin-right: 5px;"></span> <b>GIUGINE - PIETROSCHE - PIACCINE.</b> Depositi clastici alluvionali, lacustri e fluviali (argille, ghiaie, tufi). Depositi argillo-sabbiosi-conglomerati a calcareo-dolomi, di facies marina.</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffcc; border: 1px solid black; margin-right: 5px;"></span> <b>MIOCENE SUPERIORE.</b> Depositi argillo-sabbiosi, calcarei, gessosi e dolomitici ("formazione gessoso-sabbia").</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffcc; border: 1px solid black; margin-right: 5px;"></span> <b>MIOCENE.</b> Depositi calcareo-conglomerati, argillosi, maronitici, marini e lacustri (fino a conglomerati d'Oligocene, di facies marina). Frequenti spessi di madriperforazione, talora depositi calcarei e calcareo-sabbiosi. Depositi lacustri in luoghi ligurici.</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffcc; border: 1px solid black; margin-right: 5px;"></span> <b>PALEOGENO.</b> Depositi marini, prevalentemente calcarei, talora di facies di Puvoli. Depositi calcareo-marini e maronitico-argillosi, talora dolomiti calcarei calcarei, di facies marina. Depositi conchoidi in luoghi ligurici.</li> </ul> <p><b>MIocenico</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #add8e6; border: 1px solid black; margin-right: 5px;"></span> <b>CRETACEO - GIURASSICO - TRIASSICO s.l.</b> Depositi prevalentemente carboniferi di "parafacile", calcari spessi (scleriti, marne e argille, dolomi talora con gessi) di facies marina. Depositi clastici granulari di facies continentale ("Venetico" s.l., p.p. di età permiana).</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #add8e6; border: 1px solid black; margin-right: 5px;"></span> <b>TRIAS ALPINO.</b> Depositi calcarei, dolomitici talora con gessi, calcareo-conglomerati, di facies marina, associati a rocce eruttive.</li> </ul> <p><b>PALEOZOICO</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffcc; border: 1px solid black; margin-right: 5px;"></span> <b>PERMIANO - CARBONIFERO.</b> Depositi clastici, prevalentemente arenaceo-conglomerati, calcarei, marne ed argille, di facies marina. Depositi prevalentemente argillosi, talora con arenarie e clasti granulari, di facies continentale ("Venetico" s.l., p.p. di età permiana).</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffcc; border: 1px solid black; margin-right: 5px;"></span> <b>DEVONIANO - SILURIANO.</b> Depositi argillosi, calcarei-argillosi ed arenacei, di facies marina.</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ffffcc; border: 1px solid black; margin-right: 5px;"></span> <b>CAMBRIANO.</b> Depositi arenacei, carboniferi ("Metifero") e argillo-sabbiosi, di facies marina.</li> </ul>	<p><b>ROCCE ERUTTIVE</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Gneiss ed altre plutonici scorie (Oligocene alpino).</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Gneiss ed altre plutonici scorie (Oligocene etrusco-eto-adiatico).</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Vulcaniti scorie (Oligocene alpino).</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Vulcaniti basiche (Oligocene alpino).</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Vulcaniti di composizione mista (Oligocene alpino).</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Roca basiche ed ultrabasiche ("Gefelli" e "Pave Verdi").</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Vulcaniti prevalentemente acide (Oligocene etrusco).</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Vulcaniti basiche (Oligocene etrusco-eto-adiatico).</li> </ul> <p><b>ROCCE METAMORFICHE</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Gneiss, micaurici, (filici), quartz.</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Calcareniti.</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Dolomi, kraigati, gneiss, ecc.</li> </ul>
--	---

**CORPI MINERARI**

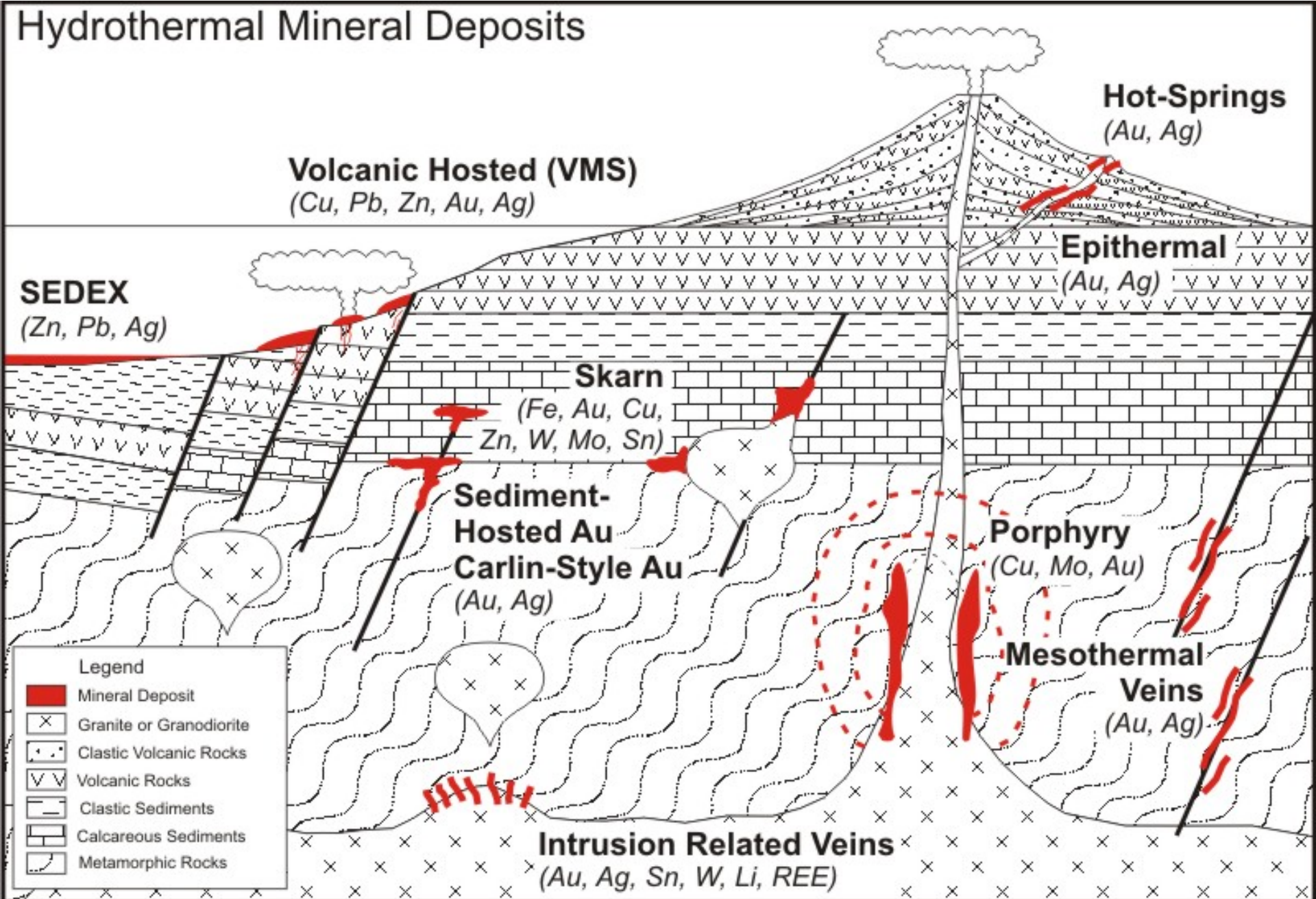
<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Rame (1%), manganese (1%), nichel (1%), cobalto (1%), cesio (1%), niobio (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Mercurio (1%), antimonio (1%), arsenico (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Piombo (1%), zinco (1%), stagno (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Piombo (1%), zinco (1%), argento (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Fluorite (1%), bario (1%), calcite (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Bauxite (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Altri metalli: uranio (1%), berillio (1%), molibdeno (1%), vanadio (1%), tungsteno (1%), selenio (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Micaurici e altre industriali: fillosilicati (1%), quarzo (1%), magnesite (1%), amianto (1%), talco (1%), carbonio (1%), bentonite (1%), sabbie silicee e da abrasione (1%), grafite (1%), rocce argillose e bituminose (1%), bauxite (1%), perlite (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Sodio (1%), potassio (1%).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Combustibili solidi: antracite (1%), lignite (1%), lignite (1%), lignite (1%).</li> </ul>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Riformazione (1/decennio).</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Situazione discordante con gli strati.</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Situazione congrua con gli strati.</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Anomali, mineralizzazione massiva o disseminata.</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Residuo sito di alterazione.</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Non definita.</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Dentro strato.</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Fuori strato.</li> <li><span style="display: inline-block; width: 15px; height: 15px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> Minerale attivo nel 1973.</li> </ul>
--	---

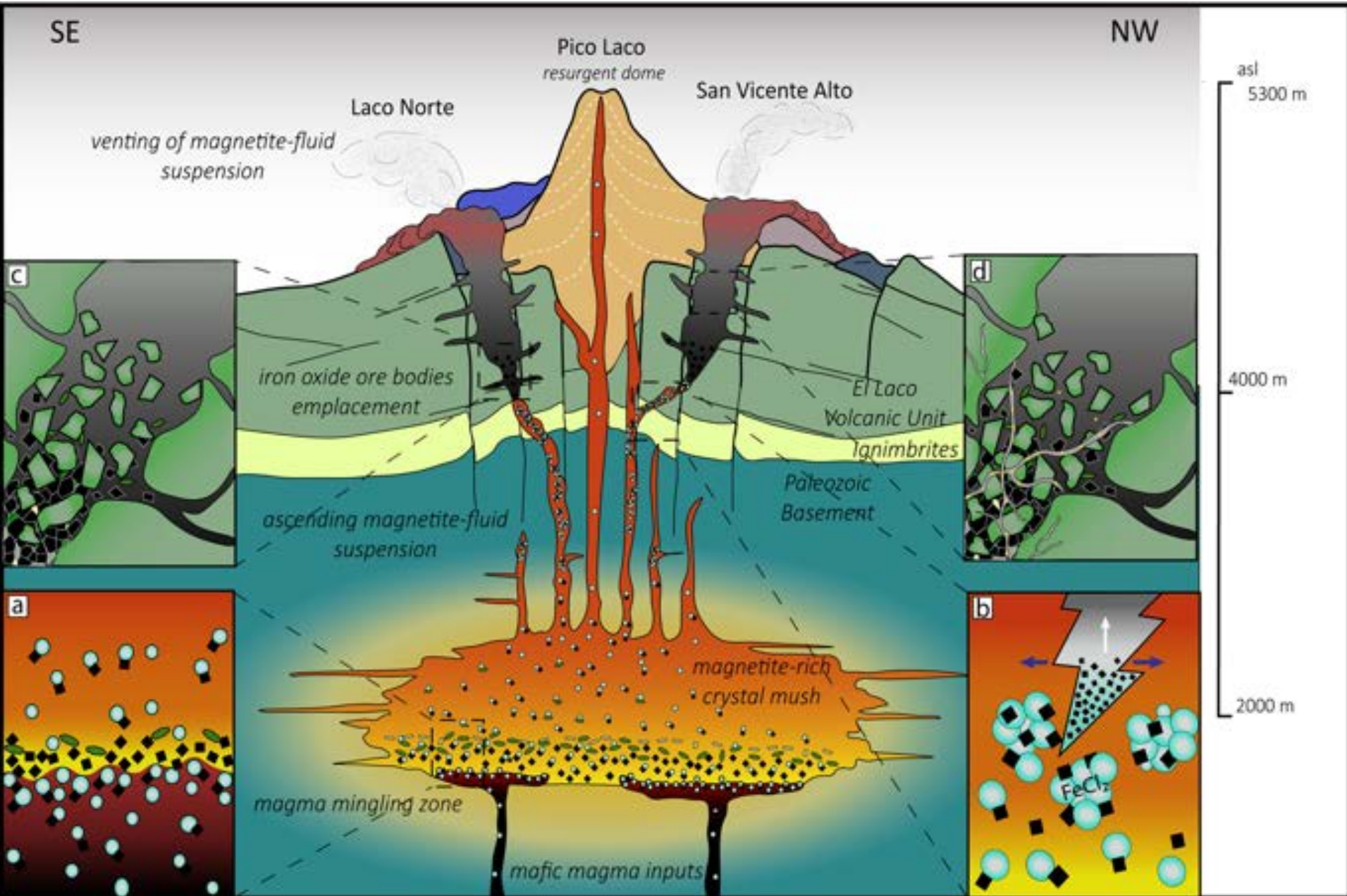
Litografia Artistica Cartografica - Firenze  
 Scala 1:1.000.000



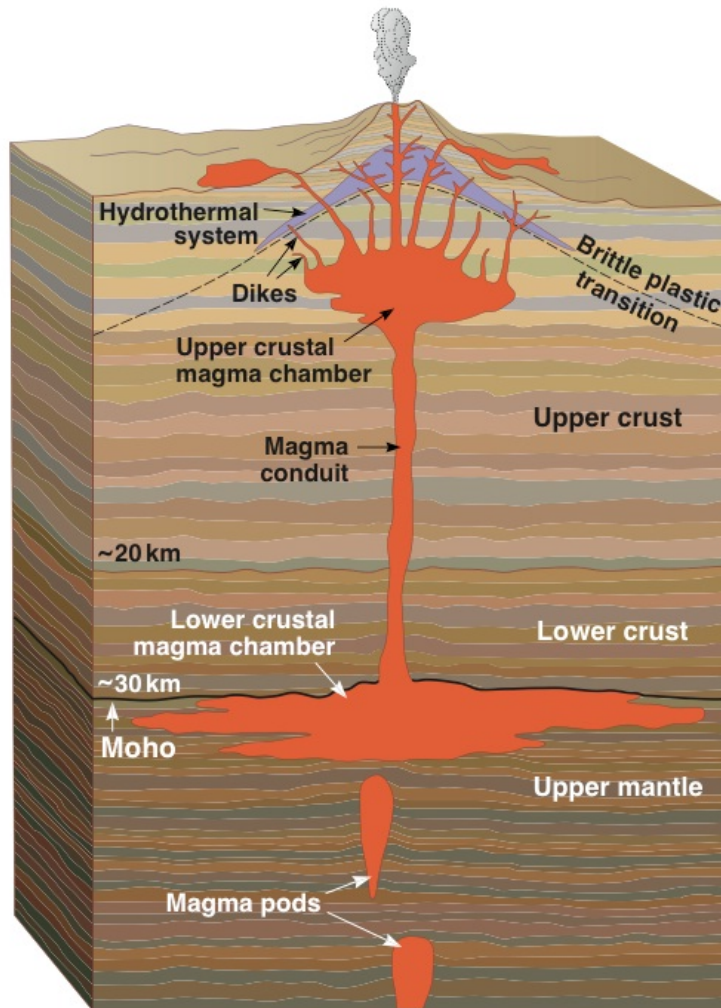


# Hydrothermal Mineral Deposits



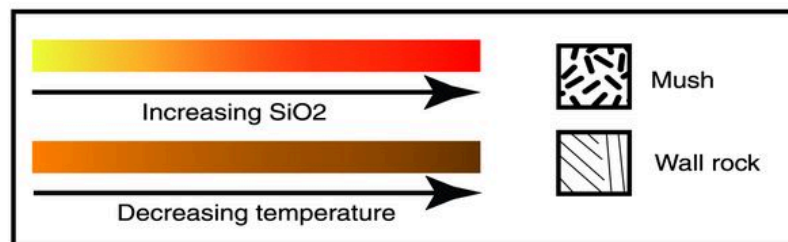
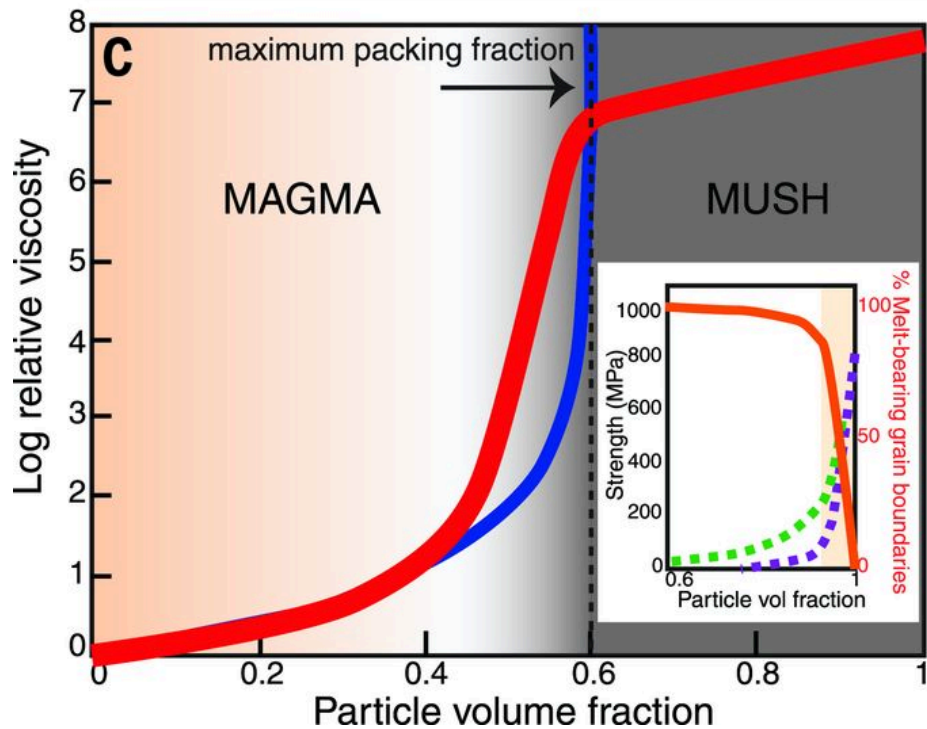
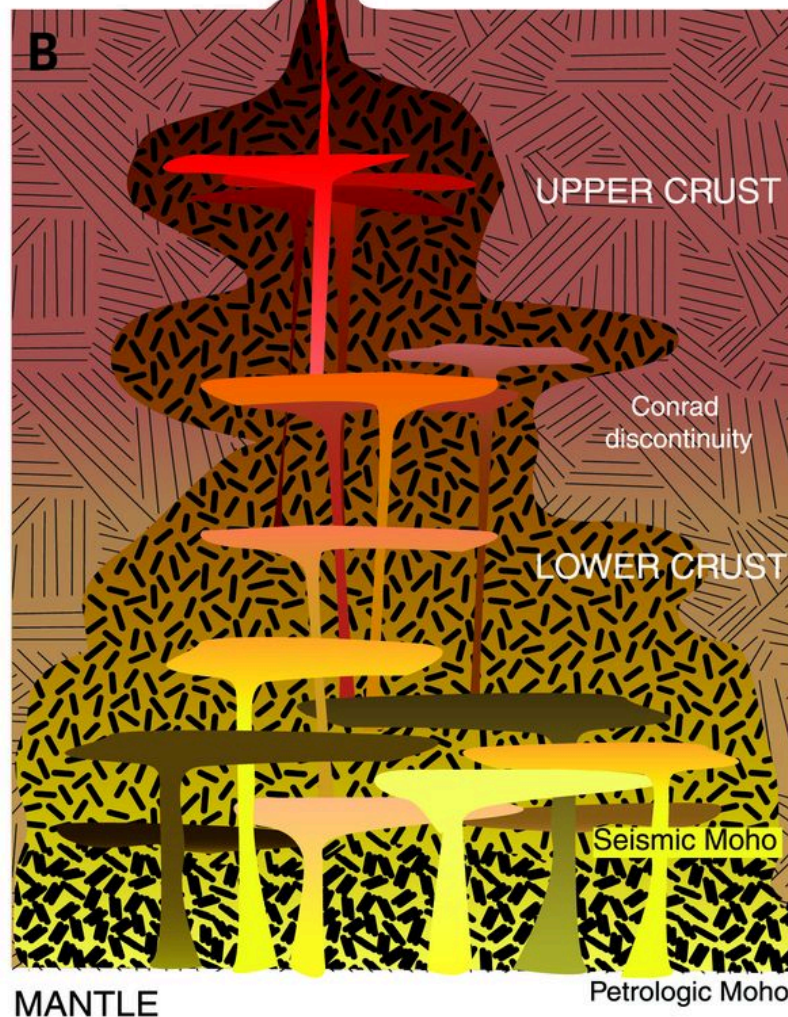
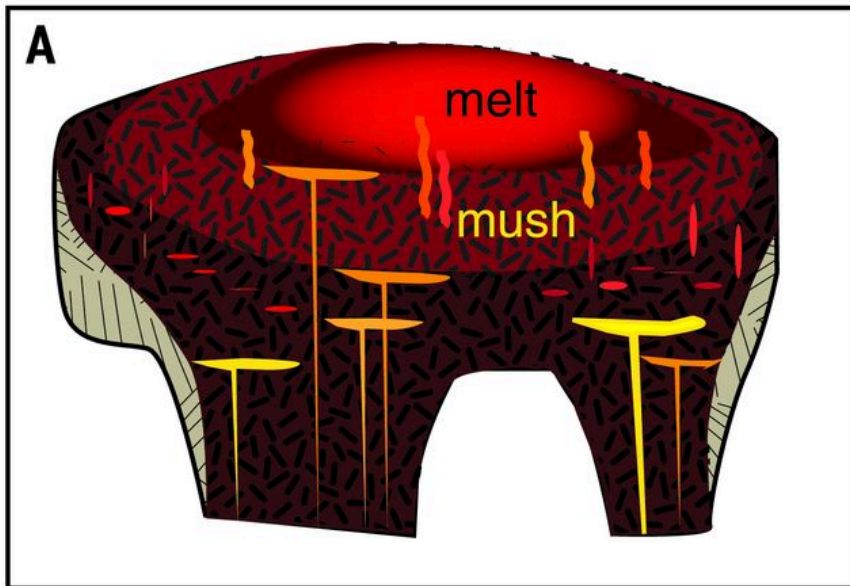


...per comprendere l'evoluzione dei sistemi magmatici e dei vulcani



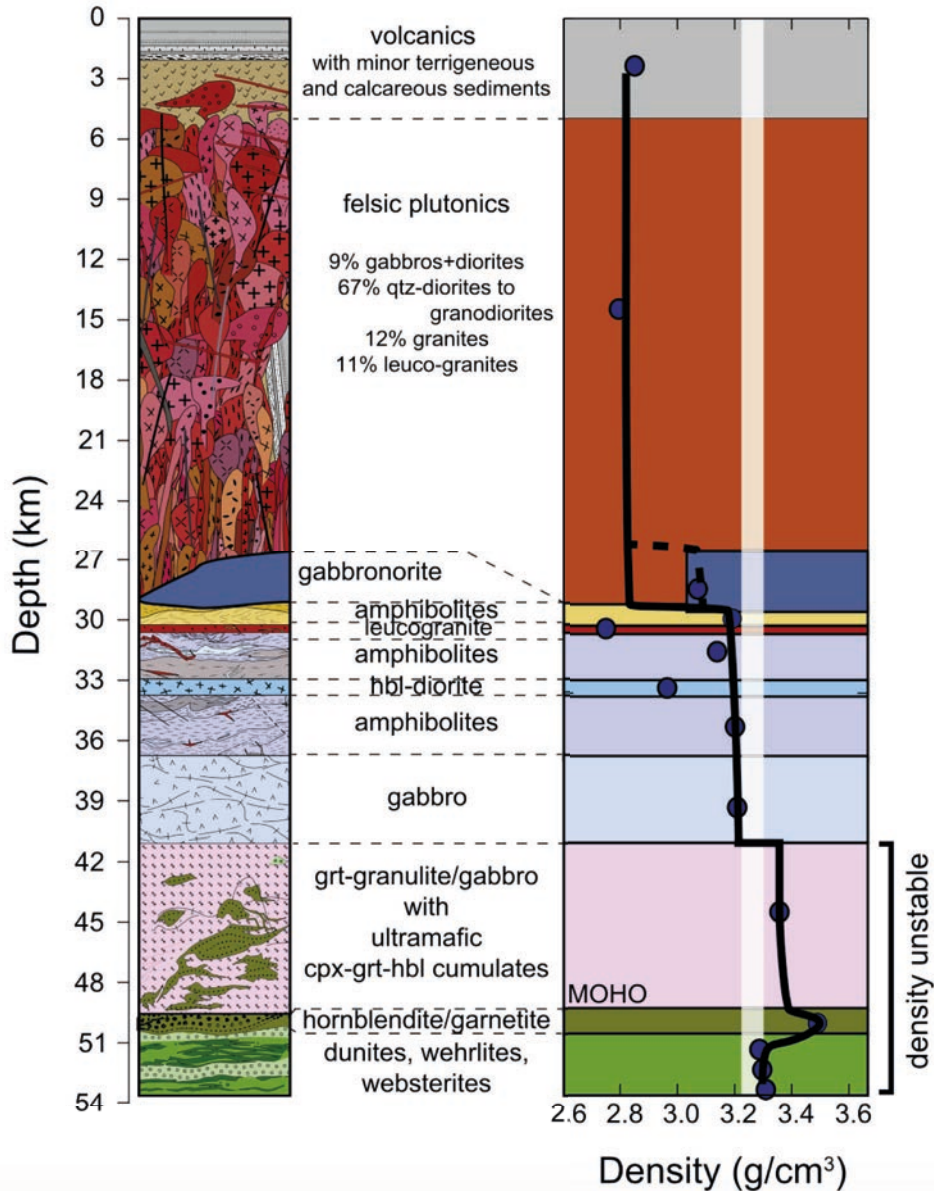
<https://magmamovesinfits.files.wordpress.com>

**Magma ascension and storage at the base of the crust.**

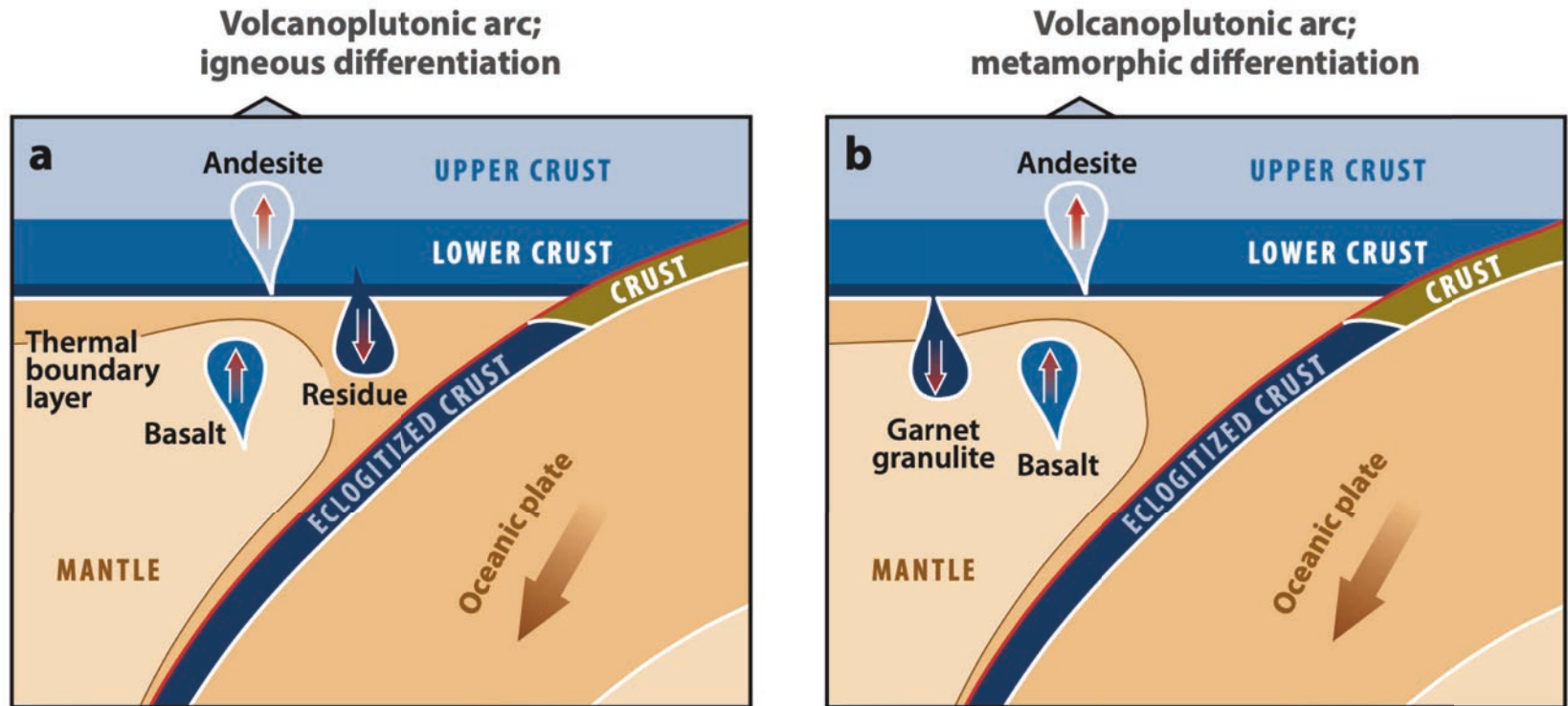




# ...per comprendere la natura e l'evoluzione del mantello e della crosta terrestre

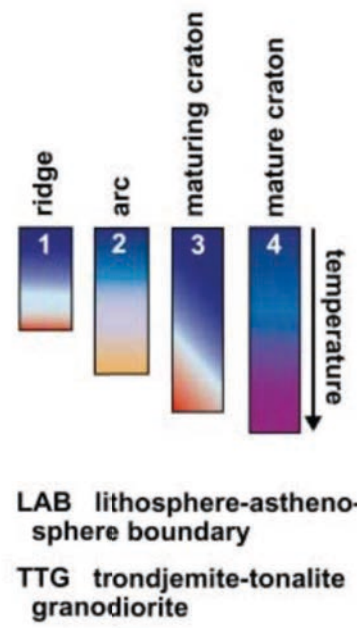
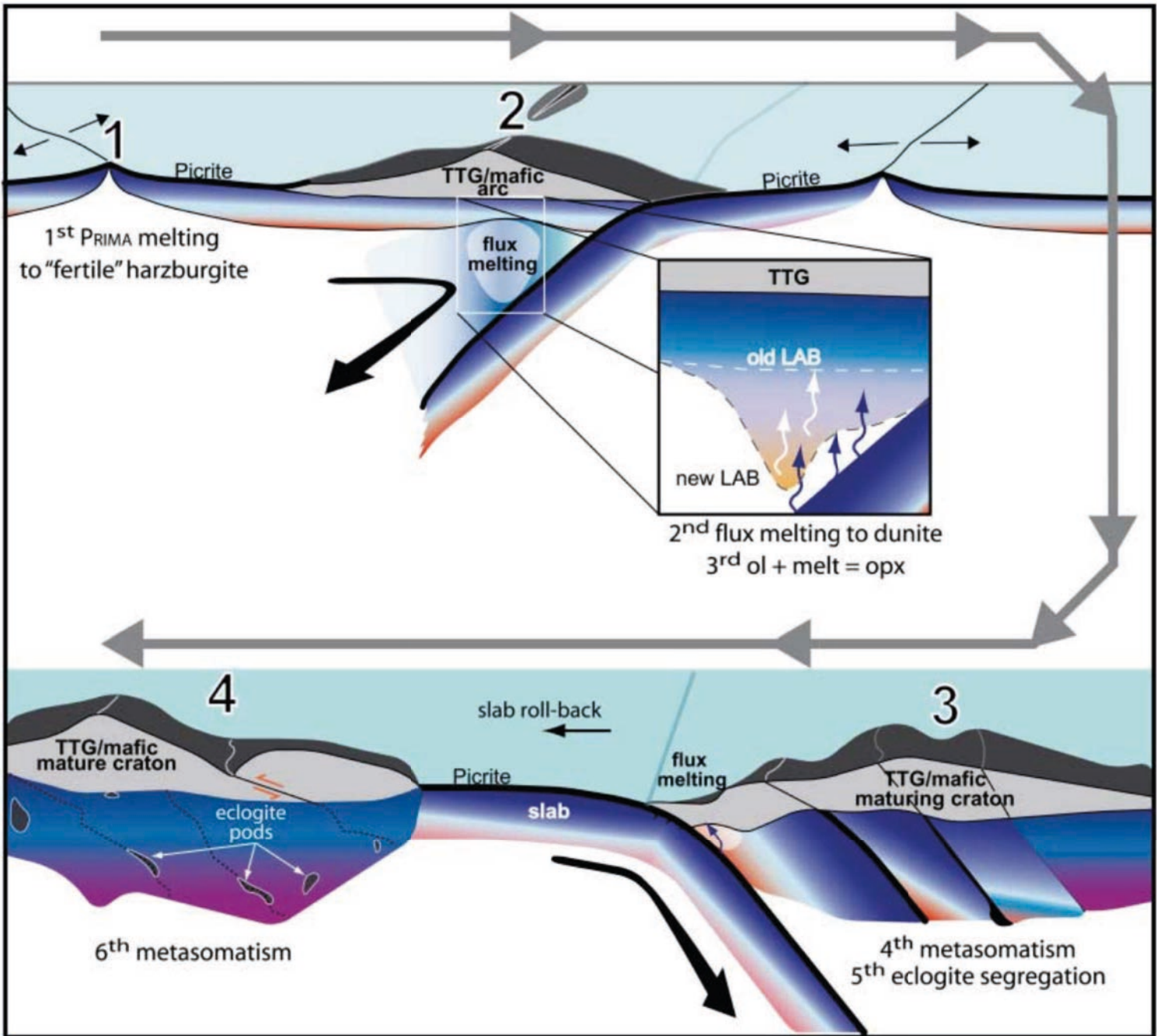


*Jagoutz & Schmidt (2013; EPSL)*



**Figure 12**

Long-term change in the composition of the continental crust has conventionally been viewed as the result of two major subduction factory processes. (a) Mantle-derived magma introduced into volcanoplutonic arcs differentiates into an andesitic fraction that is retained in the crust and an ultramafic cumulate that becomes part of the mantle (Arndt & Goldstein 1989). (b) Mafic rock at the base of a thick volcanoplutonic arc is converted into garnet granulite and sinks into the mantle (Herzberg et al. 1983).



Pearson & Wittig (2008; JGS)