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ALKALI-SILICA REACTION POTENTIALLY BEARING MINERALS IN ALLUVIAL DEPOSITS OF CALABRIA, UMBRIA, AND TOSCANA REGIONS (ITALY)

Giampiero Barisone*, Giannantonio Bottino* and Riccardo Pavia*

* Dept. of Georisorse e Territorio, Politecnico di Torino,
Cso Duca degli Abruzzi 24, 10129 Torino, Italy

1. INTRODUCTION

The paper reports the results of the second part of a large work the authors are carrying out over the Italian peninsular territory south of the river Po (1). This work, which began in 1985 and is now near to its conclusion, aims to individuate the presence and the distribution - in recent and actual alluvial deposits - of alkali-silica reaction potentially bearing minerals. In particular, alluvial deposits of three Italian regions (Calabria, Umbria and Toscana) are here examined, and the results of the study are synthetized in three schematic maps at about 1:1,500,000 scale.

2. GEOLOGICAL FEATURES

The geological formations more extensively outcropping in the range of the Apennini mountains are mainly composed of sedimentary rocks of Mesozoic and Cenozoic age; the central part of Tirrenian side (West) is nevertheless prevailingly formed by volcanic formations whose age varies from Pliocene (in the North) to pleistocene (in the South), whilst in the extreme South of the mountain range (tip of Calabria) Hercynian granits and old acid metamorphic rocks (gneisses, etc.) outcrop on wide areas. Sedimentary and volcanic rocks contain some lithologies that are characterized by a relatively high content of potentially reactive silica (opal, jasper, calcedony, radiolarites, etc.) and it is from the erosion of these lithologies that the chert presence (indicating by means of this generic term all the reactive minerals - undulatory extinction quartz excepted) in actual alluvia of Apennines water courses comes. A study was therefore carried out to divide the Apenninic rocks in groups, according to the presence or absence of chert in them; Tab. 1 shows the most extensively outcropping siliceous formations in the Italian Apenninic regions here considered. The age of these sedimentary formations ranges from Jura to Miocene; however, chert has been found more frequently in Mesozoic formations representing "complete series" and in rock referring to some Miocene stages

FORMATION	LITOLOGY	AGE
"Bisciaro"	marls with black cherts	Langhian
"Schlier"	marls sometimes with thin layered cherts	Langhian
"Scaglia"	limestones and marly limestones often with chert	Paleogene Cretaceous
"Macigno del Mugello"	sandstones and marls with lenses of black chert	Paleogene
"Argille varicolori"	shales and blocks sometimes of jaspers and radiolarites	Paleogene
"Pietraforte"	sandstones and marls with nodules of gray chert	Upper Cretaceous
"Marne a Fucoidi"	clayey micrites often with layers of chert	Middle Cretaceous
"Maiolica"	gray limestones with thin layered flint	Lower Cretaceous
"Calcare Rupestre"	micritic limestones with nodules and layers of gray flint	Cretaceous Upper Jurassic
"Rosso ammonitico"	marly limestones and cherty marls	Upper Jurassic
"Calcare diasprigni"	limestones with thin layered flint	Jurassic
"Calcari ad Aptici"	layered limestones with lenses and thin layers of chert	Middle Jurassic
"Corniola"	limestones with brown chert nodules	Lower Jurassic

Tab. 1a - Main chert-bearing formations outcropping on Toscana and Umbria regions.

FORMATION	LITOLOGY	AGE
"Gorgoglione" flysch	marls and sandstones sometimes with chert	Middle-lower Miocene
"Calcari di Nova Siri"	limestones with layers of white or gray chert	Lower Miocene
"Argilloscisti varicolori" Complex	shales and limestones sometimes with cherty elements	Paleogene
"Scaglia rossa"	marly limestones often cherty	Paleogene Upper Cretaceous
"Saraceno"	shales and limestones occasionally with flint nodules	Upper Cretaceous
"Flysch galestrino"	shales and limestones with flints interbedded	Cretaceous Upper Jurassic
"Lagonegro"	marly limestones and cherty marls	Jurassic
"Calcescisti Auct."	carbonatic schists locally associated with radiolarites	Jurassic
"M. Facito"	marly limestones with chert	Middle Triassic

Tab. 1b - Main chert-bearing formations outcropping on Calabria Region.

DISTRICT	NUMBER OF SAMPLES	CHERT				QUARTZ AND FELDSPARS	
		AVERAGE (%)	STANDARD DEVIATION	VALUES (%) MAX	VALUES (%) MIN	AVERAGE (%)	STANDARD DEVIATION
UMBRIA	14	5,3	3,2	12,9	2,2	30,0	20,3
TOSCANA	32	7,2	5,2	23,9	1,1	53,0	16,1
CALABRIA	49	3,3	4,2	20,4	0,3	70,2	19,3

Tab. 2 - Statistical data on aggregates composition

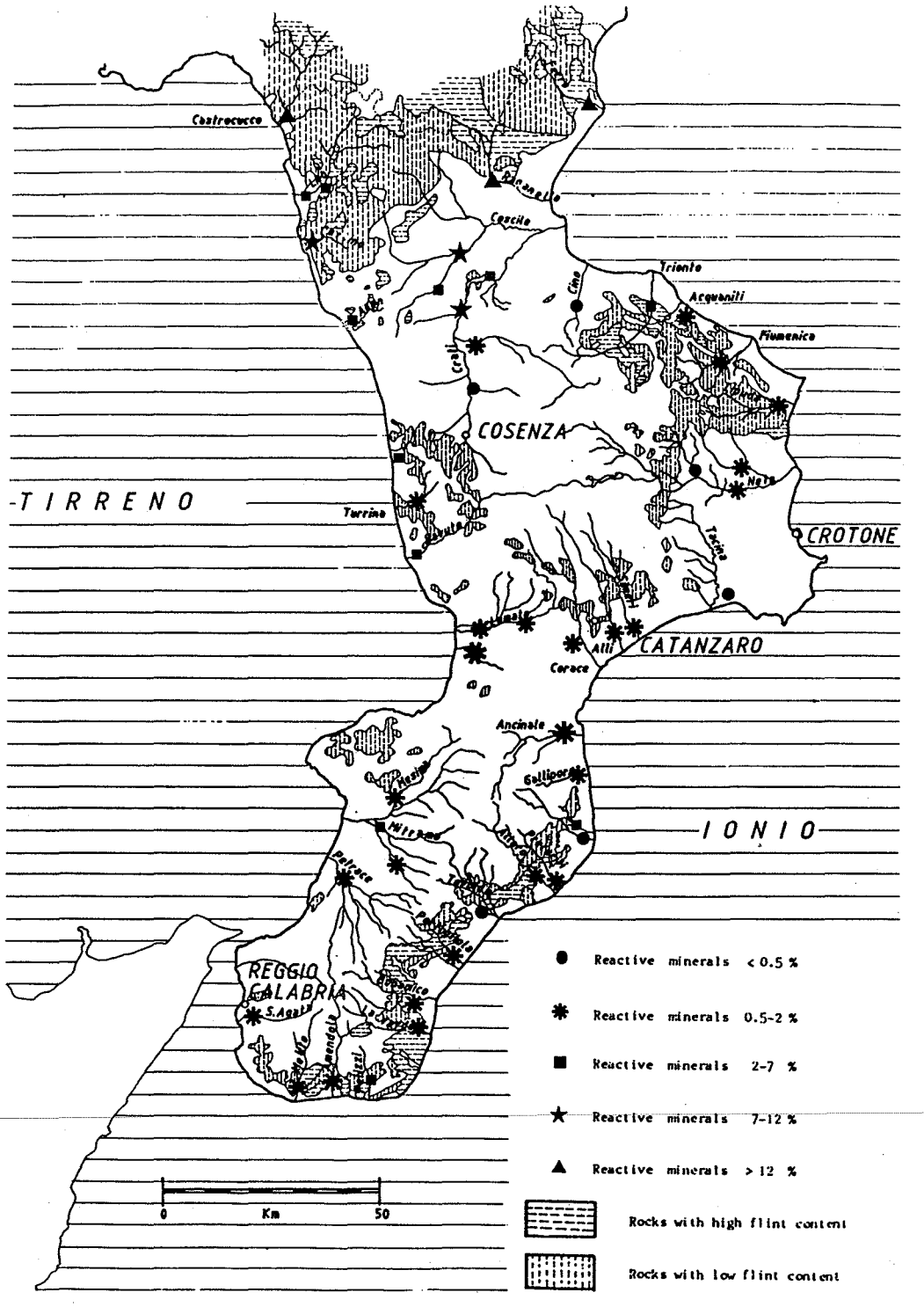
(Langhian, Aquitanian). Besides the distribution of outcropping chert bearing formations, the presence and the content of reactive minerals in actual fluvial deposits may be ascribed to a major or minor erodibility of "mother" rocks and to the effect of fluvial transportation.

3. ANALYSIS OF ALLUVIAL DEPOSITS

The prevailing coarse granulometry of quarryed alluvial deposits of Apennine water courses has posed great problems for a correct sampling (2), requiring the collection in situ of large amounts of material in order to obtain a representative sample: this problem was solved collecting samples - whenever possible - directly in the quarries: in such cases, thanks to the homogenization due to the industrial crushing, it was enough to take for each sample a total amount of about 5 kg of crushed sand. The about 100 samples so collected were sieved, after quartering and warm etching in diluted HCl, in order to obtain 8 granulometry classes (> 2mm, 2–1mm, 1–0.500mm, 0.500–0.250mm, 0.250–0.125mm, 0.125–0.075mm, 0.075–0.040mm, < 0.040mm) (3). The classes > 1 mm were tested by a stereoscopic mycroscope, whilst those from 1mm to 0.040mm were analyzed by a petrographic microscope, identifying a number of grains progressively increasing on the decreasing of size dimensions (from 150–200 grains in 1–0.5 mm class up to 500–600 grains in 0.075–0.040 mm class); the class <0.040mm, usually representing only a very little percentage of the total and very difficult to analyse, was assimilated to 0.075–0.040 class. The choice of an optical method for samples analysis is due to its rapidity and reliability; this method showed in effect, after some simple adaptations, a considerable reliability, providing good accuracy and repetibility (versus chemical methods, that in general were unsatisfactory to analyze the samples collected). In Tab. 2 statistical data on aggregates composition are pointed out, with a special attention for chert and quartz plus feldspar (counted together due to their less importance and to the difficulty to distinguish them in psammographic analysis).

4. CONCLUSIONS

The results obtained are summarized in the schematic maps of Fig. 1 and 2, where the chert content in alluvial deposits of the water courses studied is stated. In these maps alluvia are divided in five classes, according to their reactive minerals content: less than 0.5%, 0.5 - 2%, 2 - 7%, 7 - 12%, up to 12%. This division, originally made on the basis of bibliographic data on chert reactivity, appears now not to fit well in the real reactivity of Italian cherts, but we have preferred to maintain it also at this stage of the study, deferring the definition of new intervals to the completion of the work we are carrying out on the reactivity rating of the different reactive minerals in


Castrovillari
Pollino
Cozzo
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Trionto
Cino
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Fiumenico
COSENZA
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Tacina
CROTONE
Alli
CATANZARO
Corace
Ancinale
Gallicore
Melito
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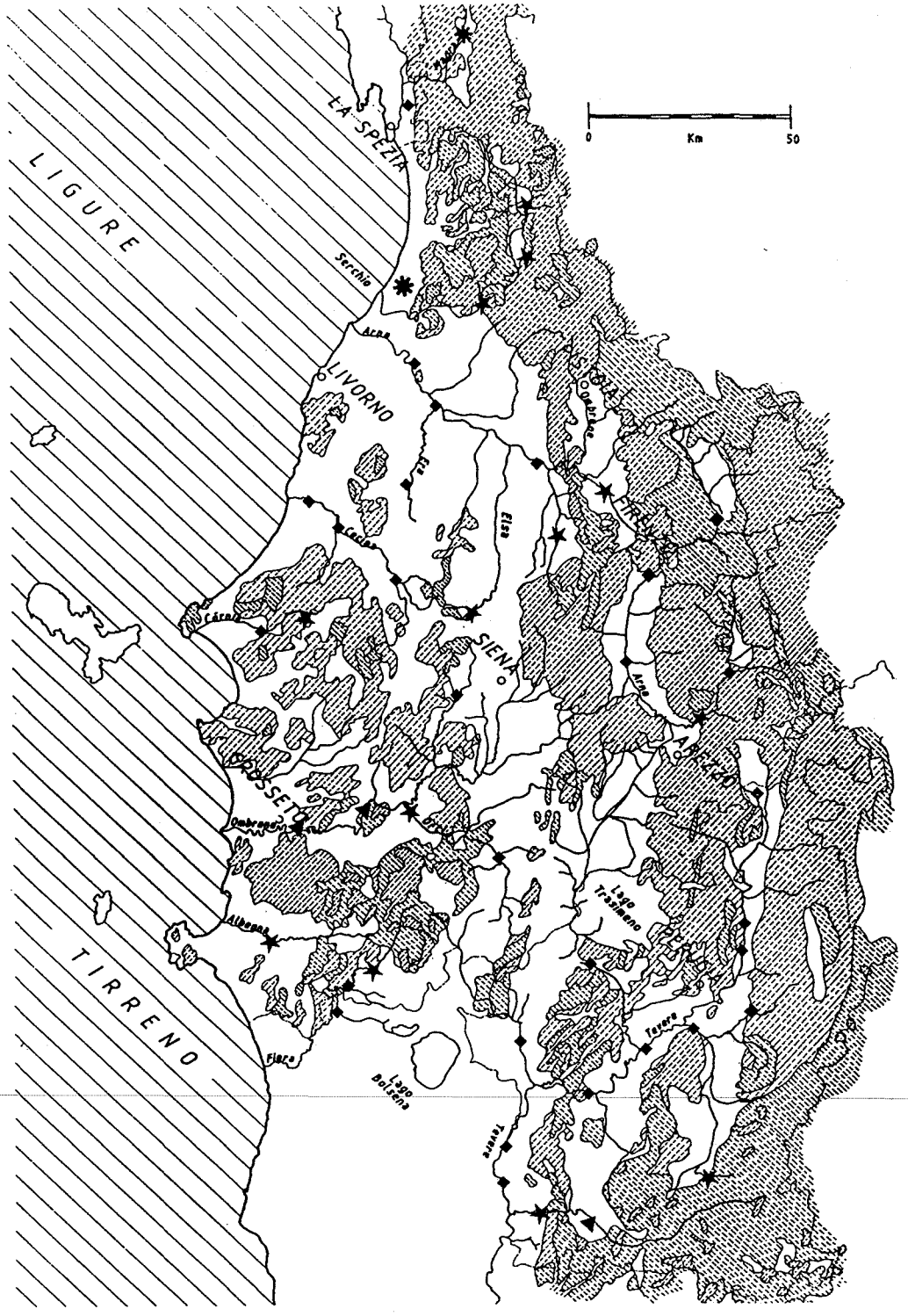
Petrace
Amendolea
REGGIO CALABRIA
S.Agata
0
Km
50
Reactive minerals < 0.5 %
Reactive minerals 0.5-2 %
Reactive minerals 2-7 %
Reactive minerals 7-12 %
Reactive minerals > 12 %
Rocks with high flint content
Rocks with low flint content


LIGURE
TIRRENO
LA SPEZIA
Serchio
Arno
LIVORNO
Cecina
Elsa
Cecina
SIENA
GROSSETO
Ombrone
Albegna
Fiora
Lago Bolsena
Tevere
Arno
Lago Trasimeno
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Italy. As far as alluvia content in reactive minerals is concerned, Calabrian rivers show a very irregular distribution, ranging from less than 0.5% to up more than 20%, according to the various kinds of rocks (igneous and metamorphic or sedimentary) mainly outcropping in the hydrographic basins. More regular is the reactive mineral content in Umbrian and Tuscanian rivers, content which never falls under 2% in the first region and under 1% in the second one, rarely rising respectively over 8% and 11%; this is undoubtedly to ascribe to the prevalence of sedimentary rocks (often chert bearing) in these regions. Schematic maps here enclosed, originally 1:500,000 scale, should be used as a base for a national rule system setting recommandations for the areas prone to cause alkali-silica reaction. It would also be useful to refer these maps to another thematic map, showing the structural damages that occurred in areas with potentially reactive aggregates; unfortunately this task appeared very difficult to achieve, due to the limited knowledge people in Italy have of the phenomenon (often not recognized) and to a certain tendency to minimize or hide it.

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