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$^{87}Sr/^{86}Sr$ ISOTOPIC CHARACTERISATION OF DOLINA SOILS AND FLYSCH ROCKS FROM TRIESTE AREA (NE ITALY)

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ABSTRACT

$^{87}Sr/^{86}Sr$ isotopic analyses have been carried on some dolina soils, sandstones and marl (flysch) from Trieste area (NE Italy) in order to look for the parent material. By comparison of the obtained results, it is suggested that the main supplies to the genesis of these dolina soils are from the rocks constituting the flysch.

Key words: $^{87}Sr/^{86}Sr$ ratio, Trieste Karst, dolina soils, flysch

INTRODUCTION

The Sr isotopes can be a powerful tool in studies of chemical weathering and soils genesis, reflecting the sources of Sr available during their formation. Isotopically distinct inputs from soil parent materials allow determination of the relative proportions of those materials entering or leaving a natural system.

This work gives a first Sr isotopic characterisation of the Trieste Karst soils, and of other sediments outcropping in the area, to evaluate the contribution of the latter in the soil genesis.

GEOLOGICAL OUTLINES

In the Trieste Karst area (NE Italy), carbonates and different types of sandstones and marls of flysch rocks outcrop (Fig. 1). Cucchi *et al.* (1987) suggest to call the whole outcropping carbonate sequence as "Trieste Karst Limestone Formation" and to subdivide it in six provisional and informal members: Mt. Coste Mbr. (Early Cretaceous p.p.; limestones and lenses of dolostones), Rupingrande Mbr. (Albian p.p.- Cenomanian p.p.; dolostones and calcareous dolostones), Zolla Mbr. (Cenomanian p.p.-Early Turonian p.p.; limestones), Borgo Grotta Gigante Mbr. (Early Turonian p.p.-Senonian p.p.; limestones, lenses of breccia bianco-rosea and presence of vadose oolites-pisolites and *Microcodium*), M.te Grisa Mbr. (Paleocene p.p.; limestones and scattered breccia level), Opicina Mbr. (Paleocene p.p.-Early Eocene p.p.; limestones) (Fig. 2). The "Carbonate Trieste Karst Formation" is sometimes filled by bauxite near the K-T transition (Gregorič *et al.*, 1998), which speaks about moments of sub-aerial exposure. The stratigraphic sequence ended with the interbedded sandstones and marls of the Eocenic flysch.

MATERIALS AND METHODS

The soils were sampled in dolinas by means of a hand drill to the depths between 50 and 130 cm. Sr isotopic compositions were measured on whole rock after dissolution of four dolinas soils samples, two unaltered sandstones and one unaltered marl by an HF-HNO_3-$HClO_4$ mixture in Teflon© vials and standard ion-exchange chromatography using DOWEX AG 50 W X8 resin. Strontium isotopic ratios were measured on a multi-collector Finnigan MAT 262 mass spectrometer at Centro di Studio per il Quaternario e l'Evoluzione Ambientale (Rome; Italy). Replicate analyses of NBS-987 standard gave an average $^{87}Sr/^{86}Sr$ ratio of 0.71025 (3), and no corrections were applied for instrumental bias. $^{87}Sr/^{86}Sr$ values, as well as chemical data of the analysed samples (obtained by means of X-ray fluorescence spectrometer; Lenaz *et al.*, 1996), are reported in Tab. 1.

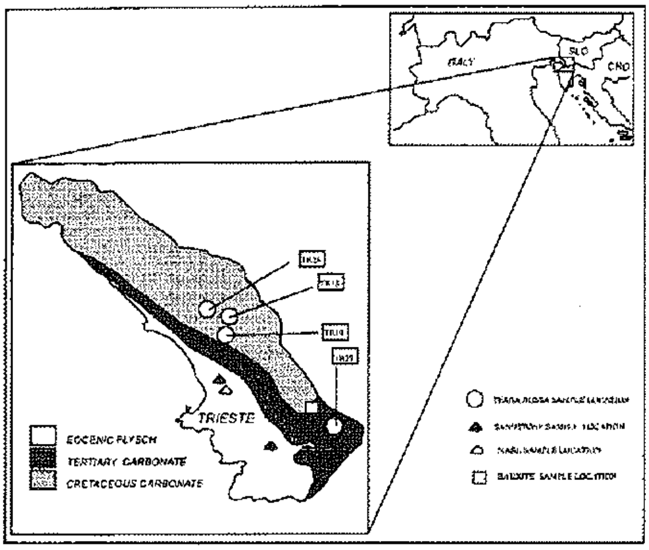

Fig. 1: Geological map of the Trieste area. Full triangle: sandstones; open triangle: marl; open circle: terra rossa; open square: bauxite (Gregorič et al., 1998) samples.
Sl. 1: Geološka karta tržaške pokrajine. Celotni trikotnik: peščenjaki; odprti trikotnik: lapor; odprti krog: terra rosa; odprti četverokotnik: primerki boksita (Gregorič et al., 1998).

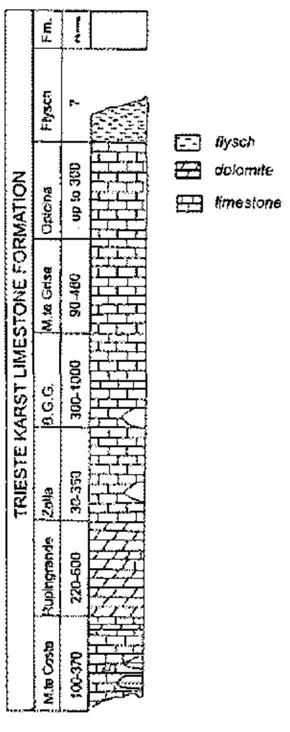

Fig. 2: Stratigraphic column of the Trieste Karst Carbonate Formation (modified from Cucchi et al., 1987).
Sl. 2: Stratigrafski stolpec karbonatne formacije tržaškega Krasa (po Cucchi et al., 1987).

Tab. 1: Chemical analyses (oxides in wt. %, trace elements in ppm) and $^{87}Sr/^{86}Sr$ ratio of the studied samples; TR: terra rossa; S: sandstones; M: marl samples.
Tab. 1: Kemijske analize (oksidi in utežni odstotki slednih mineralov v ppm) in $^{87}Sr/^{86}Sr$-razmerje analiziranih vzorcev; TR: terra rosa; S: peščenjaki; M: primerki laporja.

	TR13	TR19	TR26	TR39	S1	S2	M1
SiO_2	46.76	52.03	50.09	54.78	56.74	44.20	20.20
TiO_2	1.08	1.09	1.23	1.15	0.58	0.32	2.63
Al_2O_3	21.59	19.35	19.41	18.24	8.98	5.74	39.86
FeO	0.71	7.71	1.98	2.05	2.98	2.30	18.05
Fe_2O_3	10.56	n.d.	7.22	5.56	n.d.	n.d.	n.d.
MnO	0.18	0.18	0.17	0.14	0.25	0.12	0.01
MgO	1.59	1.97	1.80	1.86	1.84	1.36	0.14
CaO	1.01	2.22	1.57	1.37	15.78	27.67	0.24
Na_2O	0.42	0.71	0.48	0.83	1.35	0.70	0.08
K_2O	2.17	2.14	1.81	2.19	1.26	0.67	0.09
P_2O_5	0.10	0.17	0.13	0.16	0.06	0.01	0.04
L.O.I.	14.64	12.33	14.66	12.08	10.10	16.87	18.43
SUM	100.81	99.90	100.55	100.41	99.92	99.96	99.77
Cr	215	195	204	194	268	133	168
Ni	146	103	118	84	54	48	118
Rb	191	152	146	132	45	27	165
Sr	87	105	106	107	232	404	239
Nb	22	20	20	17	8	5	9
Zr	291	328	306	304	145	120	130
Y	51	51	50	49	31	23	27
Ba	149	526	448	492	149	132	n.d.
La	21	69	66	58	22	19	n.d.
Ce	42	142	161	137	41	37	n.d.
Nd	21	62	62	55	21	17	n.d.
$^{87}Sr/^{86}Sr$	0.71833 (1)	0.71762 (1)	0.71594 (1)	0.71847 (1)	0.71341 (3)	0.71523 (2)	0.72241 (2)

DISCUSSION AND CONCLUSIONS

$^{87}Sr/^{86}Sr$ isotopic data have been compared to one another, to limestone values taken from literature (Hess *et al.*, 1986), and to the $^{87}Sr/^{86}Sr$ value of a KT bauxite outcropping near Padriciano (Gregorič *et al.*, 1998). These findings reveal that dolina soils have $^{87}Sr/^{86}Sr$ ratios ranging from 0.7159 (1) to 0.7183 (1), with a mean value very close to that of the typical terrigenous sedimentary materials of the Mediterranean area (about 0.717; Dasch, 1969). These data differ not only from the Cretaceous and Tertiary limestone data (0.707 - 0.708; Hess *et al.*, 1986; Javoy & Courtillot, 1989), but also from the $^{87}Sr/^{86}Sr$ values of the bauxite at the K-T transition near Padriciano (0.7080 ± 1; Gregorič *et al.*, 1998). This happens because all the sediments of the carbonate sequences, and the sediments related to subaerial exposure interbedded in, were re-equilibrated in seawater conditions.

Samples of flysch show $^{87}Sr/^{86}Sr$ values of 0.7134 (3) - 0.7152 (2) and 0.7220 (2) for sandstones and marl, respectively. The values of terra dolina soils are included in this range and are intermediate with respect to the ones obtained for sandstone and for marly components of the flysch itself.

In Fig. 3 the flysch and the dolina soils in a K_2O vs. $^{87}Sr/^{86}Sr$ diagram are represented. The samples show a good positive correlation and are best approximate by a second-degree polynomial function (R^2=0.97) evidencing that dolina soils could be generated by a mixing of sandstones and marls. In the carbonate K is under 66 ppm (Comin Chiaramonti *et al.*, 1982) and the value of $^{87}Sr/^{86}Sr$ is lower than 0.708 because this is the value of the pre-Tertiary sea (Hess *et al.*, 1986). This fact seems to exclude an important contribution of $^{87}Sr/^{86}Sr$ from carbonate sequence and bauxite level because it will have lowered the isotopic ratio. Moreover, it is possible to notice that TR sample overlying carbonate rocks of different age, TR39 and TR13, have the same $^{87}Sr/^{86}Sr$ isotopic ratio.

In conclusion, the $^{87}Sr/^{86}Sr$ data seem to confirm that the flysch components are the best candidate to explain the dolina soils source. In fact previous mineralogical studies on the same soils (Lenaz *et al.*, 1996) and previous comparisons of the Cr-spinel crystal-chemistry from dolina soils with the one from the flysch (Carbonin *et al.*, 1999), indicate the main source of these soils in the flysch material.

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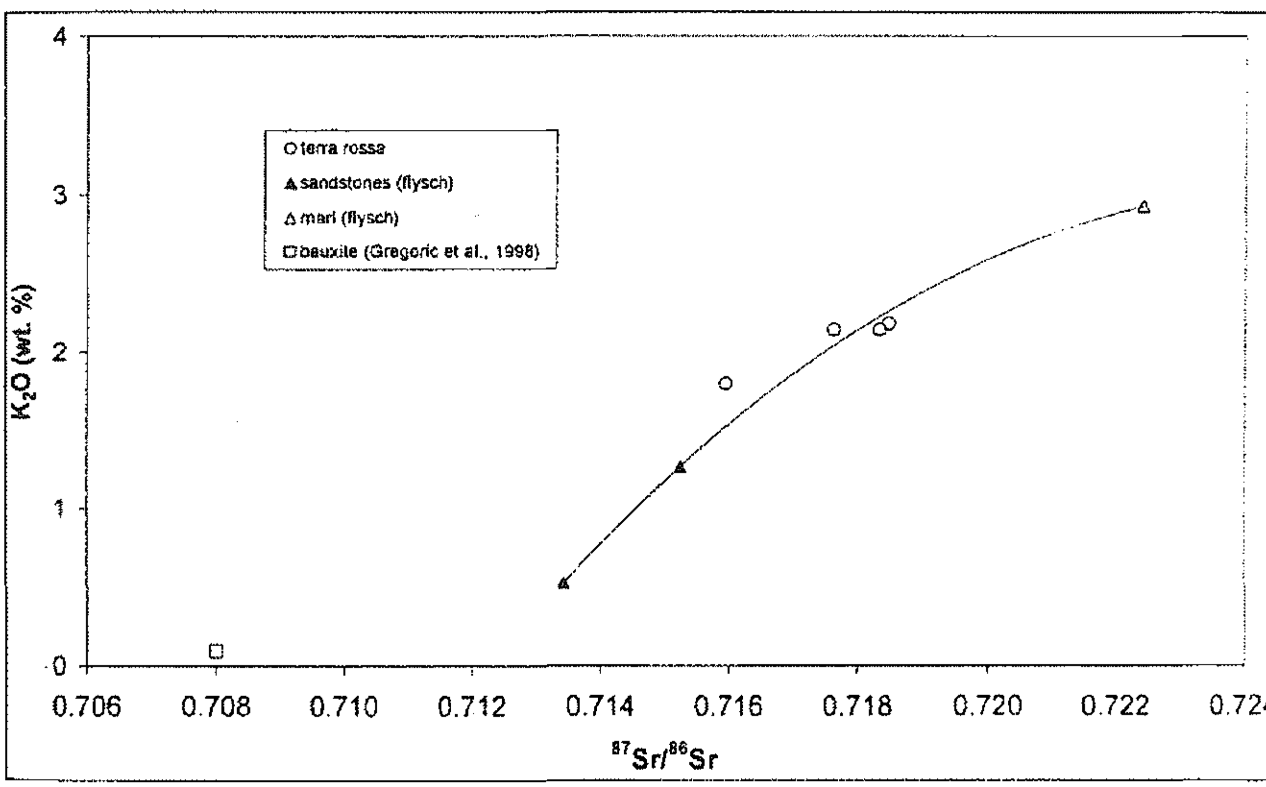

Fig. 3: K_2O vs. $^{87}Sr/^{86}Sr$ diagram; symbols as in Fig. 1.
Sl. 3: Diagram K_2O proti $^{87}Sr/^{86}Sr$; simboli kot na sl. 1.

$^{87}SR/^{86}SR$ IZOTOPSKA KARAKTERIZACIJA PRSTI DOLIN IN FLIŠNIH PLASTI IZ OKOLICE TRSTA (SV ITALIJA)

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POVZETEK

Da bi ugotovili izvorne kamnine prsti v nekaterih dolinah v okolici Trsta, smo izvedli $^{87}Sr/^{86}Sr$-izotopske analize teh prsti, flišnih peščenjakov in laporjev. Ob primerjavi dobljenih rezultatov domneva, da gre nastanek prsti v dolinah pripisati predvsem kamninam, ki sestavljajo tamkajšnji fliš.

Ključne besede: razmerje $^{87}Sr/^{86}Sr$, tržaški Kras, prst, "doline", fliš

REFERENCES

Carbonin, S., Menegazzo, G., Lenaz, D. & Princivalle, F. 1999: Crystal chemistry of two detrital Cr - spinels with unusual low values of oxygen positional parameter: Oxidation mechanism and possible clues to their origin. N. Jb. Miner. Mh., H8: 359-371, Stuttgart.

Comin Chiaramonti, C., Pirini Radrizzani, C., Stolfa, D. & Zucchi Stolfa, M. L 1982: Contributo alla conoscenza di alcuni termini carbonatici del Carso Triestino (M.Lanaro - CEDAS). GORTANIA - Atti Museo Friul. Storia Nat., 4:5-30, Udine.

Cucchi, F., Pirini Raddrizzani, C. & Pugliese, N. 1987: The carbonate stratigraphic sequence of the Karst of Trieste (Italy). Mem. Soc. Geol. Ital., 40: 35-44, Roma.

Dasch, E. J. 1969: Strontium isotopes in weathering profiles, deep-sea sediments and sedimentary rocks. Geoch. et Cosmoch. Acta, 33: 1521-1552, Amsterdam.

Gregorič, M., Caffau, M., Lenaz, D. & De Min, A. 1998: Late Maastrichtian - ?Paleocene unaltered glassy microspherules at Padriciano (Trieste Karst, NE Italy): a preliminary report. Razprave IV, Razreda SAZU, 39/6: 211-233, Ljubljana.

Hess, J., Bender, M. L. & Schilling, J. G. 1986: Evolution of the ratio of Strontium-87 to Strontium-86 in seawater from Cretaceous to Present. Science 231: 979-984, Washington.

Javoy, M. & Courtillot, V. 1989: Intense acidic volcanism at the Cretaceous-Tertiary boundary. Earth Planet. Sc. Lett. 94: 409-416, Amsterdam.

Lenaz, D., De Min, A., Longo Salvador, G. & Princivalle, F., 1996: Caratterizzazione mineralogica della terra rossa di dolina del Carso triestino. Boll. Soc. Adr. di Sc. 77: 59-67, Trieste.