

The stable isotope and chemical composition Image of pedogenic carbonate in the Minusinsk Basin, South Siberia

Jessica Vasil'chuk¹, E.A.Ivanova¹, P.P.Krechetov¹, V.A.Litvinskiy², N.A.Budantseva¹, Ju.N.Chizhova¹, Yu.K.Vasil'chuk¹ ¹ Lomonosov Moscow State University, Moscow, Russia, ² Paleontological Institute of Russian Academy of Sciences, Moscow, Russia

1. Introduction

Pedogenic carbonate are often used in paleoenvironmental reconstructions [2-5,7]. Carbon isotope composition may provide the information on CO_2 concentrations [2, 4] and dominant vegetation while the carbonate formation [4,5,8]. Oxygen isotope composition of carbonates refer to the temperature of their formation [5] through the direct positive correlation between air temperature and precipitation [6] and, consequently, soil water. We studied stable isotope composition and chemical composition of pedogenic coatings as reliable records of paleoenvironmental data widespread in South Siberia.

2. Study area



-1 -2 -3 -4 + -5

Fig. 1. Studies of stable isotopes in carbonate coatings in South Siberia: 1- Minusinsk Basin ; 2 - North Minusinsk Basin [Unpublished data], 3 -Ak-Khol Lake basin (Altay Mountains) [9]; 4 – Ak-Khol Lake basin (Altay Mountains) [3]; 5 – Southern Cis-baikalia [7].



Fig. 2. Study sites in Minusinsk Basin: A – Kazanovka national reserve; B – Sayanogorsk area; C – Lake Hankul.



Fig. 3. Carbonate coatings in soil profile (top left and top right picture) and on individual pebbles (bottom left and bottom right pictures). Carbonate coatings occur mainly on bottom faces of rocky fragments.





Hankul Lake.

Region	Isotope composition of coatings		_	Modern climatic parameters			
	δ ¹³ C,‰ (vs V-PDB)	δ ¹⁸ O,‰ (vs V-PDB)	Age, years BP	MAT, °C	Mean Summer T, °C	MAP, mm	Soils
sinsk basin	-6.82.5	-11.97.5	1 000±200 (¹⁴ C SOM)	+1 +4	+17 +20	340	Chernozems, Kastanozem s
sinsk basin ovka paleosol)	-2.5	-13.9	5200±1404650±180 (¹⁴ C SOM)	+0,7	+17	403	
inusinsk basin	-10.41.6	-	-	+0.5… +1.5	+16 +18	310 360	
Lake basin [9]	-6.3+8.1	-11.67.8	-	-3.1	+12 +14	130 140	Haplic Cambisols
Lake basin [3]	-2.32.7	-8.97.8	7350±30 …6060±30 (¹⁴ C carbonates)	-3.1	+12 +14	130 140	
paikalia [7]	-5.42.0	-16.310.1	<2 500	-2.7	+18	442	Chernozems
paikalia [7]	-24.1	-12.2	<22 000	-2.7	+18	442	

elements and isotope composition of different layers.



Fig. 10. Stable isotope composition of carbonates does not correlate with isotope composition of modern vegetation and soil water., R^2 value is significantly less than 0.5. That (together with Table 2 and Fig. 7 data) may mean that the vegetation during the formation of all carbonate coatings was different than modern.



ones, that contain mainly Ca.

Also estimated soil-derived CO₂ concentration is much lower than preindustrial atmospheric level. Several trace elements content in pedogenic coatings shows higher values than natural abundance due to the local geochemical features (Tl,Te, Ba, Hf, Cs, Dy, Sn, Nb, Cu, Se, Er, Rb, Be, Bi, Eu, Yb, Pr, W, Sm, Li, Ce, As) and probably to the anthropogenic pollution of recent centuries (Pb, Co, Ni).

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Table 3. Median value content
of elements in coatings (M) in
comparison to natural
abundance of elements in
carbonate rocks (A): M>A;
M≈A; M<a< b=""></a<>

Element	Median,	carbonate		
	ppm	rocks nnm [1]		
Ph	4 180	0.040		
ті	0.070	0,040		
Co	6.425	0,001		
Te	0,420	0,001		
Ba	238 700	10,000		
Hf	0.835	0.040		
Cs	0.945	0 100		
Dv	1,785	0,200		
Sn	0.735	0.100		
Ni	14.600	2.000		
Nb	1.845	0.300		
Cu	21,250	4,000		
Se	0.400	0.080		
Er	0.925	0,200		
Rb	12.700	3.000		
Be	0.380	0.100		
Bi	0.038	0.010		
Eu	0.705	0.200		
Yb	0,785	0.300		
Pr	2,745	1,100		
W	0,360	0.200		
Sm	2,245	1,300		
Li	8,180	5,000		
Се	19,050	12,000		
As	2,670	1,700		
Zr	28,800	20,000		
Zn	27,250	20,000		
Sb	0,250	0,200		
Мо	0,480	0,400		
Cd	0,120	0,100		
V	22,950	20,000		
Ga	4,510	4,000		
Th	1,835	1,700		
Cr	11,350	11,000		
Sr	401,500	610,000		
U	0,960	2,200		
Sc	4,170	10,000		
La	9,975	29,000		
Y	9,615	30,000		
Gd	2,095	8,000		
Lu	0,125	0,500		
Но	0,320	1,300		
Та	0,120	0,500		
Nd	11,250	47,000		
Tb	0,310	1,300		
Tm	0,125	0,900		

5. Conclusions

Carbonate coatings isotope and chemical composition show variability in different layers of coatings. Inner (older) layers contain Fe and Al, and have more positive δ^{13} C values and less positive δ^{18} O values than younger

 δ^{18} O values of soil pore water differs much from the δ^{18} O of precipitation due to the evaporation and mixing in soil, that shows that, the carbonate δ^{18} O should not be interpreted directly in any case as a function of precipitation and air temperature. In the particular case study of carbonate coatings of Minusinsk hollow, δ^{18} O values of carbonates do not correlate with modern soil water δ^{18} O values.

 δ^{13} C values of pedogenic carbonates show no correlation with modern vegetation, probably the vegetation during the formation of carbonates (both younger than 1368...630 cal. years BP and aged 6346 to 4928 cal. years BP) more C_4 vegetation existed in a region.

. In general, isotope composition of coatings of age from 6346 to 4928 cal. years BP shows that the environment was dryer) and cooler (lower δ^{18} O values) than present, that fact does not contradict with paleocarpology data obtained earlier for the region. In addition, this value is close to data obtained for Ak-Khol lake basin, where the conditions due to high elevation and extra continental location are cooler and dryer than in Minusinsk Hollow.

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