GIS model of ore deposit Fe-Mn crust from the seamounts of Sierra Leone Rise.

Asavin A.M*. Chesalova H.I.**
**** Vernadsky Institute of Geochemistry and Analytical Chemistry, 117945, Moscow, Kosigina str.19*** alex@geokhi.ru
***** Vernadsky Geological State Museum Moscow, Moshovai str. 2. 11*** lena@sgm.ru

Abstract

There are 3-D models of the ore deposit from the Karter seamount from the Atlantic ocean were observed. There is the numerical model of genesis Fe-Mn crust on the volcanic rocks from the seamount a new, perspective type of the Fe-Mn ore were constructed by the GIS method. Also we build draft technical economical model of ore mining and estimated main parameters values.

Introduction

After 1980 years, attention on the Fe-Mn crust on the oceanic bottom as ore potential source slowly decrease. This decrease results failed operation of exploration and mine workings Fe-Mn nodules on Clarion-Clipperton region, Hawaiian ore region and other regions on oceanic bottom and regions of oceanic ridge by USA firms.

The investigation of Fe-Mn core on the seamounts and other intraplate magmatism objects is causing a rebirth of interest in this ore type. High concentration of the Co, MnO, NiO, Platinum group elements (EPG), TR make it perspective product on the world market. From the other side technology of mine workings from seamounts ore zone more complex and consistence of the ore material (kg/m^2) less then for nodules on the oceanic bottom. The present paper is dealing with methodic procedures of estimation useful mineral reserves on the seamounts by GIS method and some simplest model of the geneses Fe-Mn core.

GIS model

For calculation area of the seamounts slope we used GIS program Arc. Info 8.2. As initial information we used GEBCO (General Bathymetric Chart of the Oceans) [1]. On the base on this information we construct 3-D surface models of the seamounts Sierra Lione rise. The sample of such of 3-D computers models exposed on the fig 1 for one of the seamount Corner rise. We use triangulation method, calculate area (as degree) for each of the triangle and categorized data from the four class (0-1, 1-5, 5-15, >15 degree of the slope). From the software Arc Info used two method for build model of the surface GRID and TINs (triangulated irregular network). The raster show surface as regular network with known or interpretative value of argument Z. The surface represent by TINS as set of points. The irregular network of this points form as a sequence of triangles. TINs are designed to capture and represent surface features such as streams, ridges, and peak. Tins represent surfaces as contiguous nonoverlapping triangular faces. You can estimate a surface value for any location by sample or polynominal interpolation of elevations in a triangle. Because elevations are irregularly sampled in s TIN, we can apply a variable point density to areas where the terrain changes sharply, yielding an efficient and accurate surface model. Linear features such as ridges are represented by a connected set of triangle edges. Mountain peaks are represented by a triangle node. The TIN models are distinguished by raster representation with continues exposed of the surface. From TIN models we can handle and stored rise, slope and, break lines of the nature relief also. Since the relief surface are irregular network. We use TINs models. TIN support a variety of surface analyses such as calculation and creating profiles on aligments. TINs are well suited for large-scale mapping applications where positional accuracy and shapes of surface features are important.

Model of ore genesis

We use different 3 kinds of the surfaces as has been suggested with the classification [2] ore places by the seamount slope – flat surface and node of slope, 1-5 degree declination, 5-15, >15. Many researchers believed that density and thick ness of the ore core on the basalt is almost directly proportional to type of surface [2,3]. On the fig 2 (D) as color show different kinds of surface from the Carter sm, and from Tabl.1 calculate area and volume of the ore (m^3). There is additional limit of ore forming that is pH value of the sea water. As known there is dependence of pH value from the oceanic deep (fig 2 F). On this fig 2 we draw real and approximating curves of this function. There is the next surface pH (fig2 C) we build by this numerical function. From the next step we join maps of effectively slope and pH. There is resulting map is a map of probability of the ore deposit (fig 2 E). One of the interesting result is that – shape of the ore deposit form concentric arches and rings. There are two zones one on the 2km deep (first oxigen minimum) and second on the 4 km deep. The second zone can see on the fig.3 – model of the ore deposet Amper sm.

There is total opinion that horizontal surface more productively then other type of surface, but it type compose about 10% only. The main part of the ore surface composed 5-15 degree (about 80%). But the concentration of the ore component (Co, Pt, Ni, Mn) also depends of the type of surface. If we take into account this fact we can see that for Pt ore stock for horizontal and 5-15 degree surface similar (40, 44 %). For this reason we can simplify ore mining of this type ore.

Model of ore mining

From the Tabl.2 we calculate approximate economic effective of the ore mining only for 1 seamount from Sierra Leone rise (Carter sm.). There is the simple evidence of the perceptivity mining of the seamount as ore object. But the main conclusion from this calculation is even so one seamount ore field we can found enough high profit for exploration and mine working. There are two lines of evolution costs and profit expose on fig.4. The point of the cross these lines show the time of paying back. There is about 3 year in our case. The important conclusion of our analysis is the exchange the order metal from list of profit component. As shown on fig 3 the main worth from ore consist from Pt, Pd metal (about 50%) whereas the Ni, Co less than 15% from total profit. Another word without extraction Pt Pd from this type of ore the efficiency of work mine drop for two orders.

Type of slope	Horizontal	1-5 grad	5-15 grad	>15 grad	Total
Area (km^2)	163	124	1465	177	
Volume m^3	4645500	5096400	64606500	8619900	82968300
Gross weight dry ton.	29340	38440	454150	60180	582110
Co wt%	0.52	0.52	0.24	0.27	
Co ton reserves	152	199	1090	162	1603
Mn wt%	25.22	27.45	25.22	17.58	
Mn ton reserves	7400	10552	114537	10580	143068
Ni wt%	0.31	0.49	0.26	0.18	
Ni ton reserves	92	187	1190	105	1574
Co conventional	1.74	1.88	1.46	1.12	
Co conventional ton.	511	723	6609	671	8515
Pt ppm	10.00	2.00	0.60	0.50	
Pt kg reserves	2934	768.8	2724.9	300.9	6728.6

Table 1 Calculation reserve volume of Fe-Mn crust from s.m Carter

Expense of capitalized (mln$)		s.vessel	200		
		Explorer	30		
		Factory	10		
	A	Total	**230**		
Expense of the year (mln$)	**B**	Ore mining effective 500 ton per day	Working days per year =200 (day)	Total volume of ore per year = **100** (thousand ton)	
	C	Exploitation expense	5-30 mln$	**20**	
		Other Transport			
	D	Transport of the tank ship (50 thousand ton of the cargo capacity)	Cruises per year =**B/D** (100/50)	**2**	
	E		0.5 mln. $ for cruise	**1**	
	F	For stores ore and factory operation		**4**	
	G	Total per year		**25**	
Total time of working off (year)	**H**	Stock thousand ton ore (as 1 s.m. ample)	500		
	I	Year	**H/B**	**5**	
Advantageous for 1 s.m. (Price mln.$ for product on the year)		Total Stock of ore ton	for year ton	Price thousand $ (for 1 ton metal)	Total price
	Ni	1574	270.4	10	2.7
	Co	1603	275.4	35	9.6
	Mn	143069	24577.7	1.7	41.8
	Pt	6.729	1.2	20000	23.1
	Pd	4	0.7	30000	20.6
	J			Summa	**97.9**
	K	Profit from year		**=J-G**	**67.9**
Profit mln$	**L**	total period of work off		**=J*I**	**109.5**
Time work off	**M**			A/(J-G)=	**3**

Table 2 Calculation efficiency of operation of exploration and mine workings

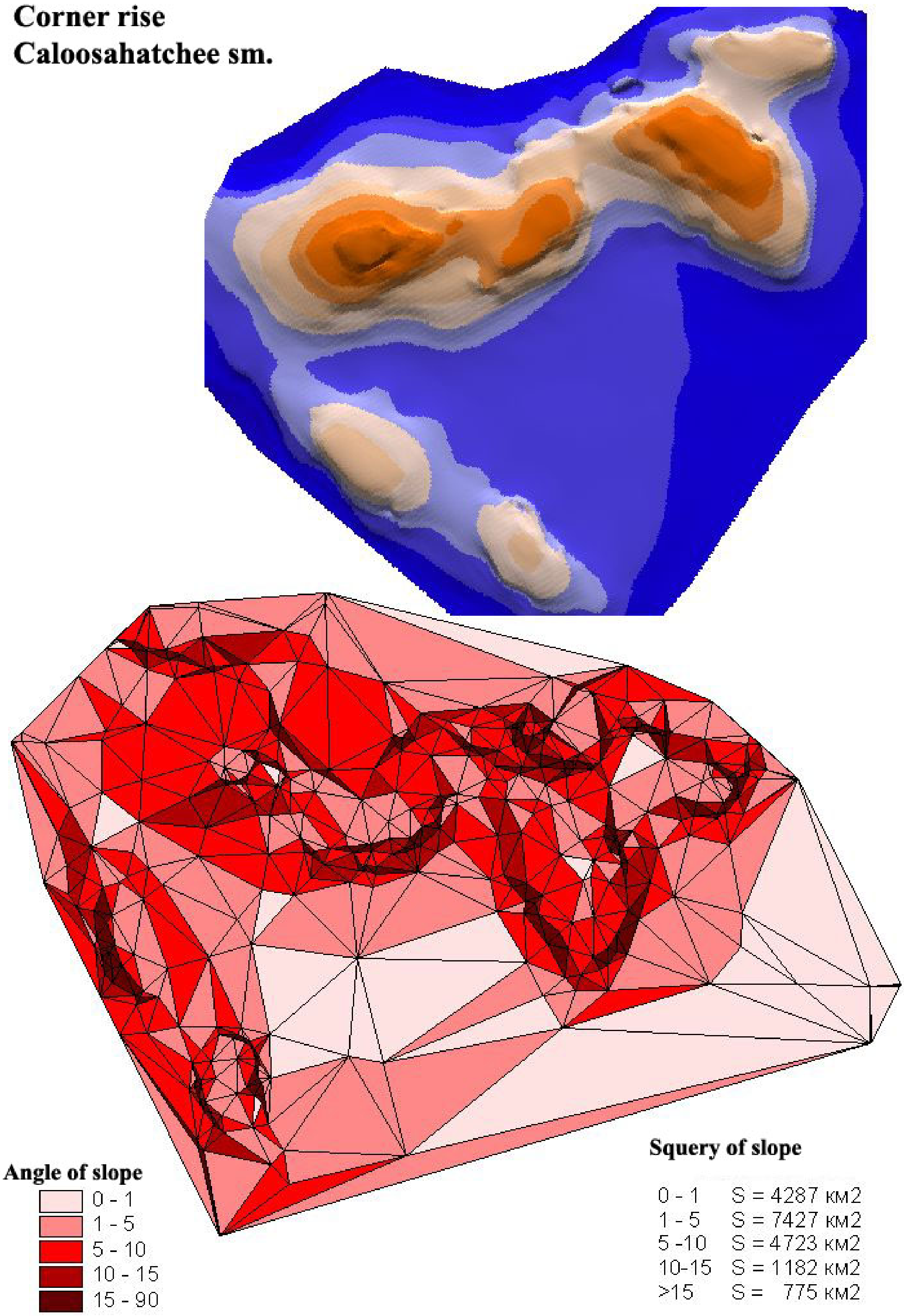

fig. 1

Figure 1 GIS 3-D Model of the Caloosahatchee s.m from the Corner rise.

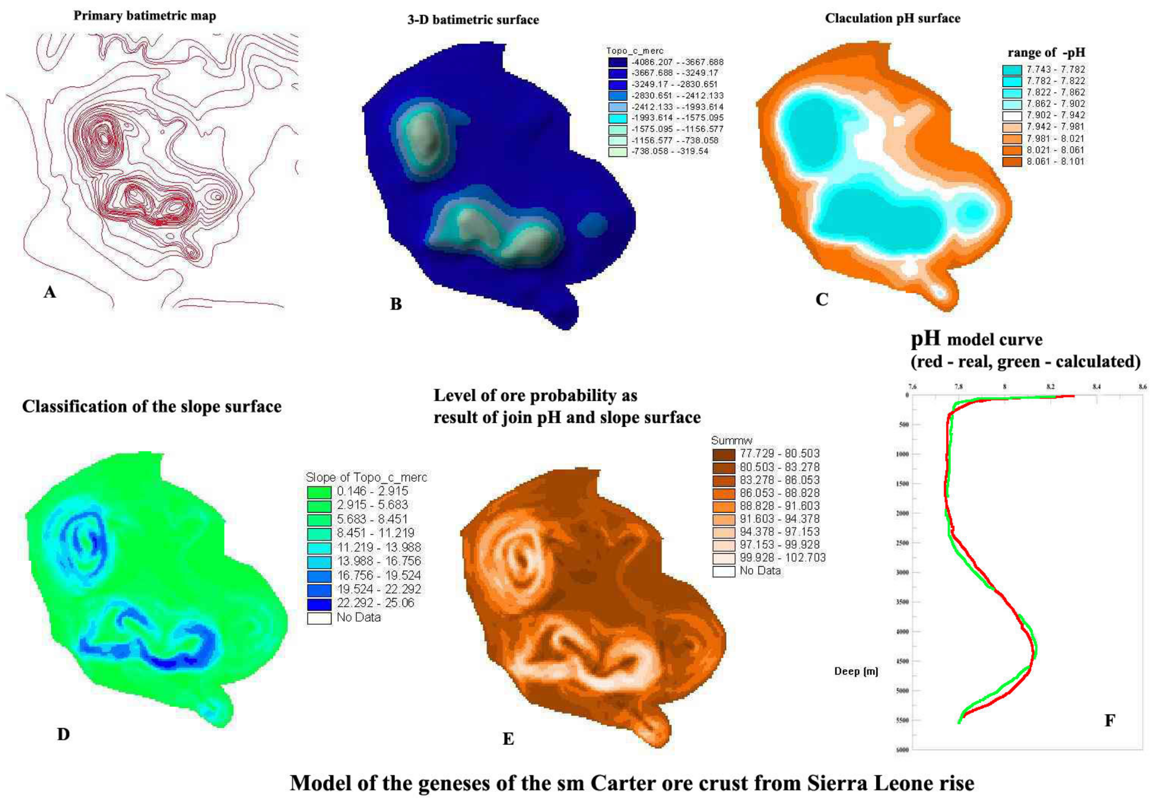

Figure 2 Model of the geneses s.m Carter ore crust from Sierra Leone rise.

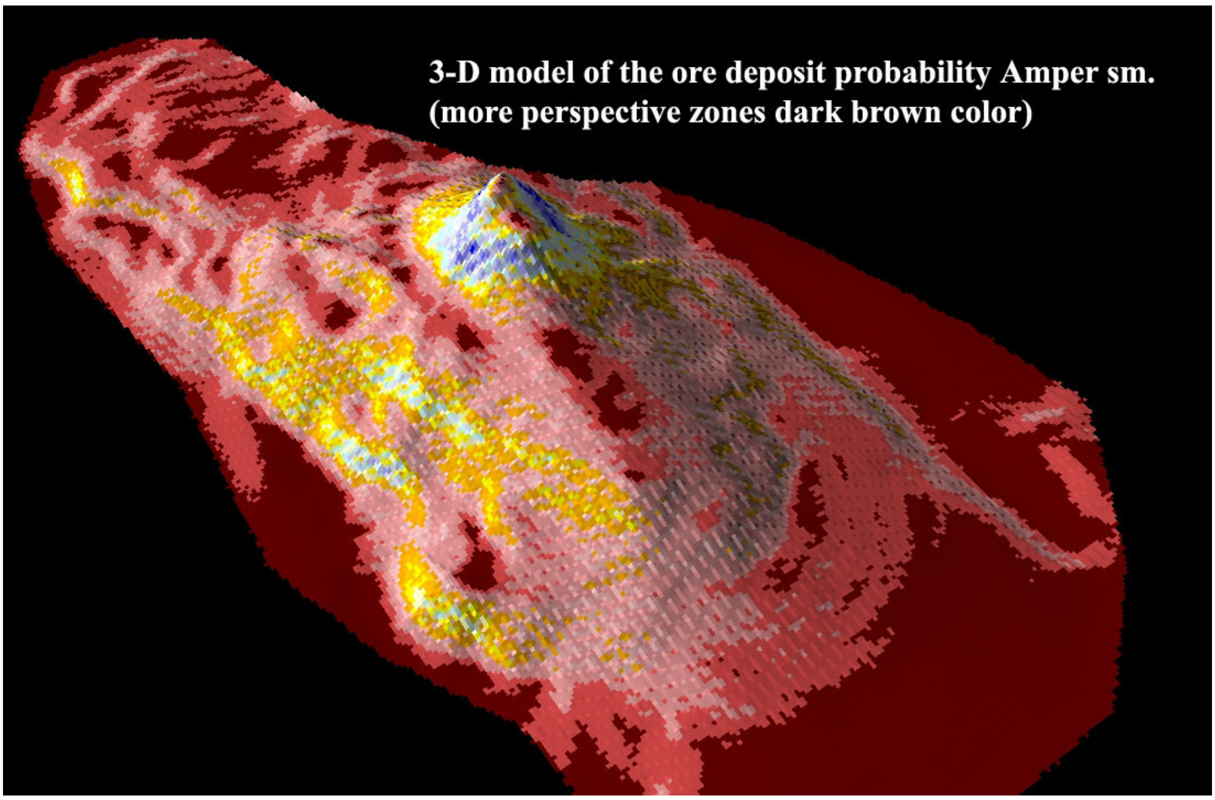

Figure 3 Model of the ore crust from s.m Amper.

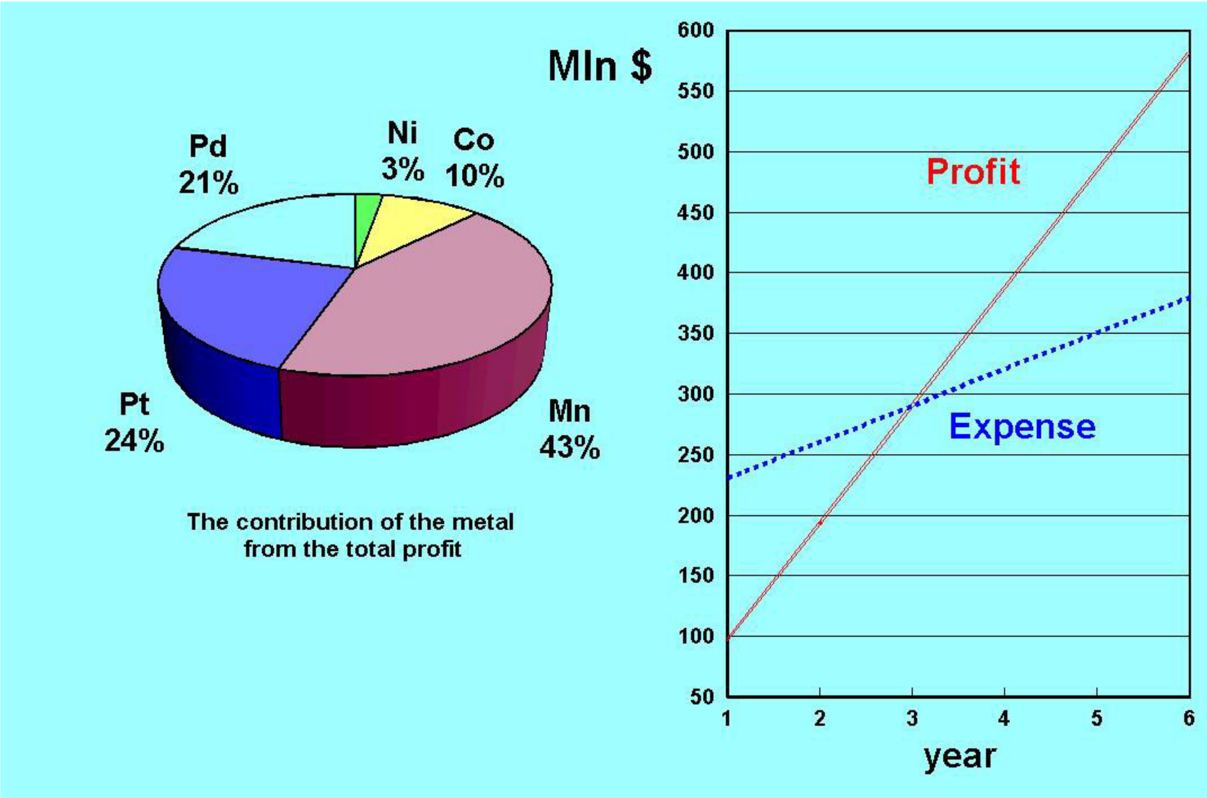

Figure 4 Economical model of the ore mining from Carter s.m

References

1. GEBCO-97 Digital Atlas CD. IHO. Natural Environment Research Council
2. Cobalt-rich ores of the World Ocean. (in Russian) Ed. S.I.Andreev. St.Petersburg, VNIIOkeangeologia, 2002, 168 p
3. Baturin G.N. The Geochemistry of Manganese and Manganese Nodules in the Ocean. (in Russian) 1988, 342 p..
4. http://www.lme.co.uk
5. http://www.metalprices.com