Placer Mineral Deposits on a Young Earth

Alexander V. Lalomov and Serguei E. Tabolitch*

Abstract

We present a mathematical model for stream placer accumulation far from the source. Determination of the model's parameters is discussed, and the model is applied to field data from northeastern Russia. The model calculated the age of these "far transfer" placers in northeastern Russia as not more than 2000 years, hundreds of times less than predicted by uniformitarian geologists. Field data were used to calculate both average and initial denudation rates during the post-Flood time for northeastern Russia. The model can be applied in similar settings to provide an age estimate for other "far transfer" placer deposits, and should provide considerable economic benefit in prospecting for commercial alluvial placer deposits.

Introduction

Determination of the age of geological features is one of the most difficult problems for modern geology. Although uniformitarian geologists routinely apply radiometric and paleontologic methods, both are based on questionable assumptions (Bliss, Parker and Gish, 1990; Snelling, 1995; Woodmorappe, 1979; etc.). We have developed a different method to determine the age of alluvial stream placers by mathematically modelling the placer deposits' generation. This model was tested with field data from northeastern Russia.

Our opportunity to constrain mathematical models by field observations of alluvial placers was provided by several cassiterite (tin ore, SnO_2) placer mines in Chukotka, northeastern Russia (Figures 1, 2). The primitive ore concentrating equipment in use at the mines is inefficient; we estimate that 30% to 40% of the available cassiterite is lost from the ore-dressing gears (ODG) during the concentration process. The cassiterite grains lost during this process are transported downstream during high flow episodes.

Between 1982 and 1990, we performed sampling of river valleys prospecting for commercial cassiterite deposits. During this work, we sampled processing residue from the ODG up to 13 km downstream, with up to a 500 m drop in elevation. Shallow (less than 20 cm from surface), fine-grained (less than 1 mm) deposits were collected, evaluated in the field, and later analyzed for tin and several other elements.

Figure 1. Study area.

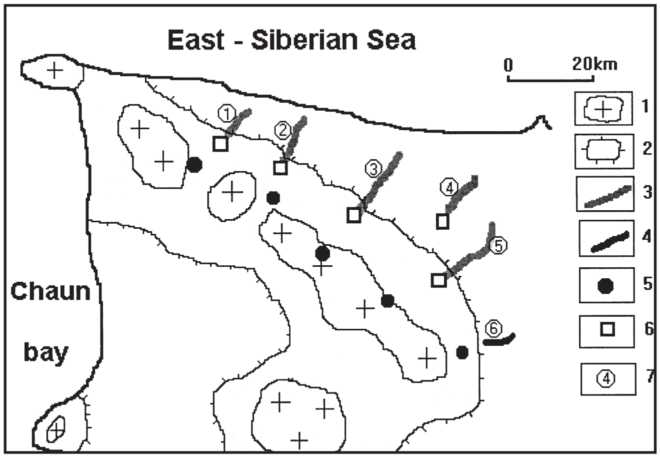

Figure 2. Detail of study area showing locations of placer deposits modeled. Key: 1 = granite intrusives, 2 = mountainous terrain, 3 = artificial tin placers, 4 = natural spit placers, 5 = tin ore sources, 6 = ore-dressing gears (ODG) locations, 7 = placer designator.

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A placer is "a surficial mineral deposit formed by mechanical concentration of mineral particles from weathered debris. The common types are *beach* placers and *alluvial* placers. The mineral concentrated is usually a heavy mineral such as gold, cassiterite, or rutile." (Bates and Jackson, 1987, p. 506). Placers can be sourced by primary deposits, and/or by pre-existing placer deposits. However, all placers are ultimately derived from primary deposits. Placers form where aqueous flow conditions allow the steady separation and concentration of heavy minerals (such as in streams or on coastal shelves). Placer deposits typically result from weathering of heavy minerals from primary lode deposits, and transportation and concentration of heavy minerals, predominantly in gravel, pebble, and boulder-sized sediments of streams (Lalomov and Tabolitch, 1997).

Placer mineral deposits can be subdivided by reference to the distance from their source. In this paper we are interested of two types: "near transfer" placers (NTP) and "far transfer" placers (FTP) of streams (alluvial placers). NTP are located near the source of ore minerals, commonly in the proximal reaches of streams often associated with significant topographic relief. They usually contain coarse grains of heavy minerals—gold, platinum, cassiterite, and wolfram (the metallic element tungsten) among other species. NTP are concentrated primarily by the winnowing of lighter minerals by stream currents. FTP accumulate downstream, far from the primary source of ore minerals. They usually contain heavy minerals of lower specific gravity than NTP minerals, and include rutile (titanium oxide), zircon (zirconium oxide), diamonds, etc., and/or fine grains of gold or cassiterite. FTP accumulate where stream current velocities decrease, allowing the settling of these heavy minerals.

Cassiterite lost from the tin mining operations migrates downstream and accumulates as artificial placer deposits (APD). Distribution of these artificial cassiterite placers is similar to that of FTP, also called "spit placers" (Wells, 1989; Bache, 1987; Yeend, Shawe, and Wier, 1989). Artificial and spit placers share a similar mechanism of formation—the consecutive deposition of minerals by their decreasing specific gravities as flow velocity decreases downstream. This similarity is confirmed by observation of residual cassiterite from the ODG. The fine-grained fraction of cassiterite lost by the ODG occurs, as a rule, in spit placer deposits. The differences between the spit placers and the APD are found in the degree of heavy mineral concentration and the thickness of the placer deposits.

Artificial placers of cassiterite have been observed as a result of 30 to 40 years of processing by the ore dressing plants. High concentrations of cassiterite have appeared in sections of valleys where they were not previously observed. NTP of predominantly coarse cassiterite grains, lost during mineral processing, have formed in proximal stream reaches downstream of the processing plants. Further downstream, the cassiterite ore is diluted by local sedimentation into the streams. In natural conditions, the spit placers would form at significant gradient changes in the streams associated with abrupt topographic elevation changes. The distribution of mineral concentrations in placers has been described mathematically (Polikarpochkin, 1976; Solovov, 1985). Residual cassiterite from the ODG enters the natural system from a defined point source. Artificial cassiterite placers from processing operations have proven to be a potential commercial source because of their high cassiterite concentrations in these secondary placers, and their near-surface location.

This paper presents a mathematical model that describes the formation of both APD and their natural analogues formed in glacial outwash zones. The model includes a method for calculating the ages of spit placers and a post-Flood denudation rate for northeastern Russia.

Mathematical Model

Our model includes the following assumptions:

Alluvial sedimentation is at a steady state during high flow times, and placer formation is evaluated under decreasing flow conditions (high flow to low flow):

I. All ore minerals entered the streams in their proximal reaches (for natural spit placers) or from the ODG sites (for artificial placers);
II. Sediment transport distance is simplified to the length of a given stream (X-axis positive downstream);
III. Source points of the ores were placed at the boundary between high topographic relief and low topographic relief (spit placers), or at the disposal point for ODG residue (APD);
IV. Time in the model is counted from the initiation of flow velocity decrease when the main phase of deposition commences;
V. The elementary cell defining the limits of transported sediment has a constant width, equal to the stream width. It has a length of OX – dX, and a height of h(X, t), reflecting the vertical capacity of precipitated loads at point = X and at time = t.
VI. The cassiterite used in the calculation (total cassiterite–background cassiterite) is C". The transport velocity associated with the cassiterite is V_r, where the subscript "r" designates the ore material. The transport velocity of the other sedimentary material is V.

VII. The rate of deposition of material through the bottom of the cell is related to its total quantity in the cell by the coefficient of proportionality, U.

VIII. Total sediment load contributed down-stream of the source is assumed to be small relative to the upstream-derived load, and is ignored in the model.

We then use the following equations to define the weight balance for non-ore and ore-bearing sediment loads accordingly:

$$\frac{dh}{dX}\mathrm{V} + hU = \frac{dh}{dt} \qquad (1)$$

$$\frac{d(C''h)}{dX}Vr + C''hU = \frac{d(C''h)}{dt} \qquad (2)$$

These equations are solved by using the exp-function to approximate the decrease in sediment load transported through a cross-sectional plane at point X = 0 during a period of decreasing flow (Kamke, 1959):

$$h(0,t) = h_o \exp(-Gt) \qquad (3)$$

$$C''h(0,t) = C_o''h_o \exp(-Gt) \qquad (4)$$

where:

G = a constant coefficient, defining existing climatic conditions of the valley;

h_o = the height of the elementary cell at point (0, 0); and

C_o'' = the contents of the ore material (i.e., cassiterite) at point (0, 0).

The solutions for non-ore and ore material are, respectively:

$$h = h_0 \exp(-Gt - (G+U)\frac{X}{V}) \qquad (5)$$

$$C''h = C_0''h_0 \exp(-Gt - (G+U)\frac{X}{V_r}) \qquad (6)$$

The total sediment load in the streams is composed of a variety of populations of different size fractions. We assume that transportation of each population is controlled by their average velocity, which decreases with an increase in the size and density of the ore particles (Shilo and Shumilov, 1976). We designate the parameters for each fraction by an index "i" and then apply formulas (1)–(6) separately to each size fraction. Then C'(X,t)—the average quantity of cassiterite minus the background quantity deposited at point X and at time t—is the following:

$$C'(X,t) = \frac{\sum_{i=1}^{N}(U(C''h)_i)}{\sum_{i=1}^{N}(Uh_i)} \qquad (7)$$

Next, we designate n_i the volume part of i-fraction in the initial transported sediment load through point X=0 at time t=0:

$$n_i = \frac{h_{oi}}{\sum_{i=1}^{N} h_{oi}} \qquad (8)$$

Then the formula (7) may be restated as:

$$C' = \frac{\sum_{i=1}^{N} C_{oi}''n_i \exp(-L_{ri}X)}{\sum_{i=1}^{N} n_i \exp(-L_iX) + \sum_{i=1}^{N} C_{oi}''n_i \exp(-L_{ri}X)} \qquad (9)$$

The second item of the denominator in formula (9) is many times less that the first one, therefore we can ignore it for simplification in solving the equation.

$$L_{ri} = \frac{(G+U)}{V_{ri}} \qquad (10)$$

There are two ore size fractions common in outlying glacial zone deposits (Shilo, 1981), implying that N=2 in formula (9). If we use the subscript "c" for the coarse (sand-size) fraction and subscript "f" for the fine (silt-clay-size) fraction, we can obtain:

$$C' = \frac{C_{oc}''\exp(BX)}{1 + m\exp(AX)} + \frac{C_{of}\, m\exp(A_{rX})}{1 + m\exp(AX)} \qquad (12)$$

$$B = L_c - L_{rc} \qquad (13)$$

$$A_r = L_c - L_{rf} \qquad (14)$$

$$A = L_c - L_f \qquad (15)$$

$$m = \frac{n_f}{n_c} \qquad (16)$$

Since the velocities of larger sediment particles are more dependent on their relative density than are the velocities of finer-grained ones (Shilo, 1981), we can predict the following relationships between the coefficients in equations (13), (14), and (15): $B<0$; $A>0$; A_r may be either >0 or <0. Depending on the particle size of the sediment load, the ore material, and features of stream in the valley; $A_r \leq A$; $B<A_r$.

In equation (12), the first term decreases much faster along the X axis, and its contribution effectively disappears at some point X. The second term reaches its maximum at point Xmax.

$$X_{\max} = -(\frac{1}{A})\ln(m(\frac{A}{A_r} - 1)) \qquad (17)$$

Thus, the function of concentration in equation (12) may have a comparative maximum sufficiently far from natural or artificial source of ore material related to the ratio of constants for every stream coefficients (13)–(16).

Solutions of the proposed equations (Figure 3) fit diagrams of heavy minerals concentrations relative to different sediment size fractions in a stream flowing from mountainous terrain to a plain described by Russian geologist B. Osovetsky (1986, Figure 51). The distribution of gold in alluvial placers (Polikarpochkin, 1976, Figure 67) is also similar to the diagram of equation (9) (Figure 4) using certain values of coefficients (13)–(16).

We can estimate values for the constants A_r, A, B, C_{of}'', and C_{oc}'' for any valley whose maximum ore concentration is downstream of the origin. We can approximate the difference $A_r - A$ for the descending slope of the curves for tin concentrations, smoothed with the filter downstream from Xmax in points X_1 and X_2, if Xmax< X_1 <X_2.

$$A_r - A = \frac{\ln(\frac{C'(X_1)}{C'(X_2)})}{X_2 - X_1} \qquad (18)$$

According to equation (12), the estimation error decreases away from point Xmax. We can determine the values of A_r and A by solving equation (17) for A by iteration (using a method of consecutive approximation). If we take "m" value from either field investigation or the literature, then we can determine an approximate value of C_{of}''.

$$C_{of}'' = C'(X_2)\frac{(1+m\exp(AX_2))}{m\exp(A_r X_2)} \qquad (19)$$

Using the same method, we can determine B and C_{oc}'' for the descending slope of the tin concentration curve nearest to point X = 0.

Figures 5a, 6a, 7a, 8a, and 9a show the field measurements of tin concentrations downstream of the placer mines in northeastern Russia (Figure 2). The curves have been smoothed by the filter. Scatter in the field data is attributed to both the small volume of the samples (about 40 cm^3) and the uneven distribution of tin in the bottom sediments. Analytical error may also contribute to the field data scatter. Superior mathematical solutions were obtained by using a filter to smooth the peaks in the field data.

Figures 5b, 6b, 7b, 8b, and 9b show the filtered (smoothed) concentrations of tin downstream from the placer mines compared to those concentrations predicted by the model for the same sections of the valleys. Figures 10a and 10b show both field data and modeled concentrations for natural spit placers of the Guravlini River (Crane Creek), (Placer 6 in Figure 2). The correlation coefficient for calculated and field data is 0.652 (Figure 11); for calculated and smoothed field data it is 0.937 (Figure 12), which indicates a genuine correlation between the model and the physical processes. Similar good correlations were also obtained for gold in spit placers (Figures 13a and 13b), but details of these data are not provided in this report.

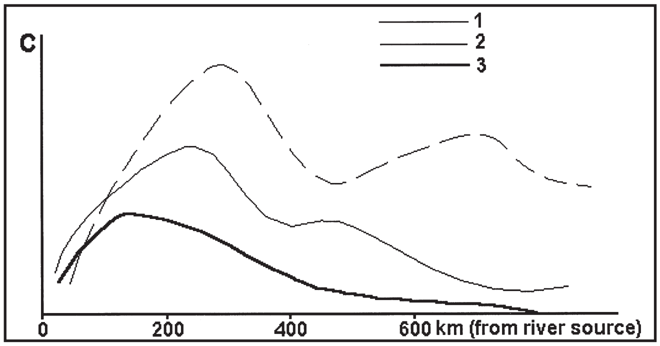


Figure 3. Concentration of heavy minerals by size-fraction in Kuban River alluvial deposits (Caucus, Russia; Osovetsky, 1986).

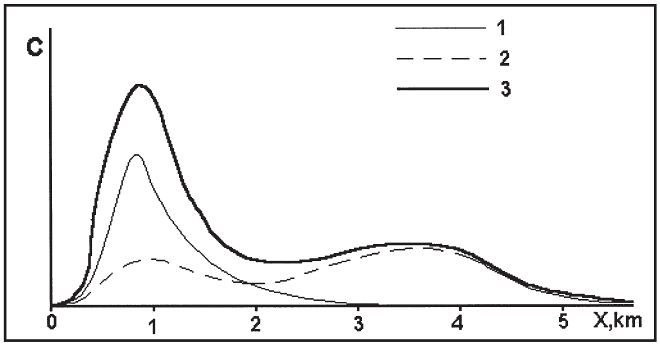
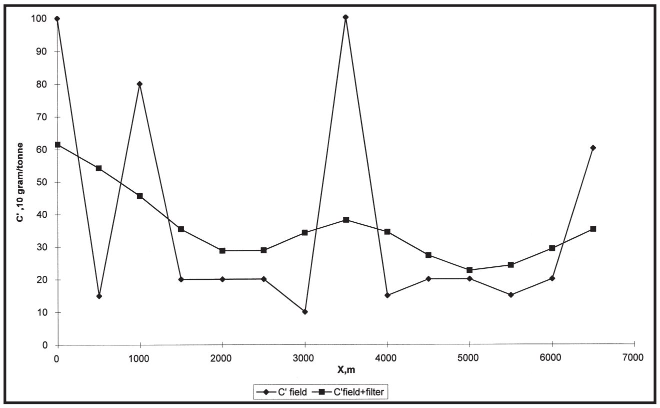


Figure 4. Distribution of gold by size-fraction in Kuobah-Boga placers (northeastern Russia; Polikarpochkin, 1976).

We conclude that the mathematical model approximates the physical processes of spit placer formation. Therefore, this method is useful for predicting tin concentrations in both natural and artificial placers. This model may be used by the mining industry to predict parameters (shape, location of placer, and concentration of heavy minerals) of economic placer deposits. In addition to the commercial value in our model, we also believe that this method can be used to estimate the age of placer deposits. The following section will discuss this application and show that it is a method that should be of much interest for creation science.

Determination of the Alluvial Placer's Age

Although the development and testing of our model was undertaken in relation to mineral exploration in northeastern Russia, Mr. Guy Berthault helped us continue our investigation and apply the model to the problem of the



Figures 5a. Original field and smoothed (filtered) field concentrations of tin in artificial spit placer 1 from Figure 2.

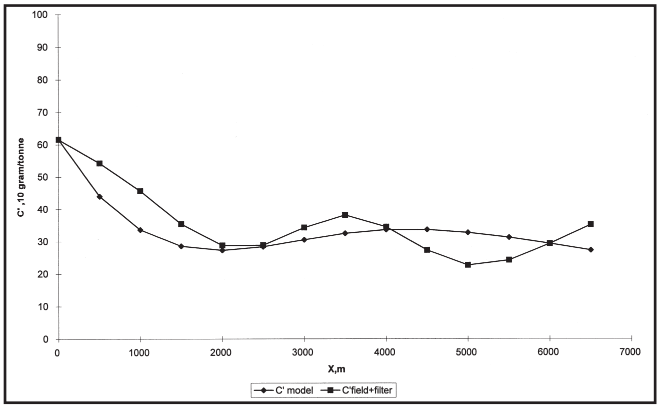
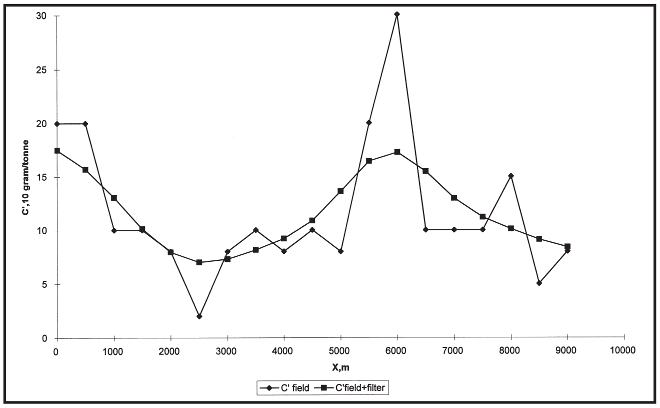


Figure 5b. Smoothed field vs. modeled concentration of tin in artificial spit placer 1 from Figure 2.



Figures 6a. Original field and smoothed (filtered) field concentrations of tin in artificial spit placer 2 from Figure 2.

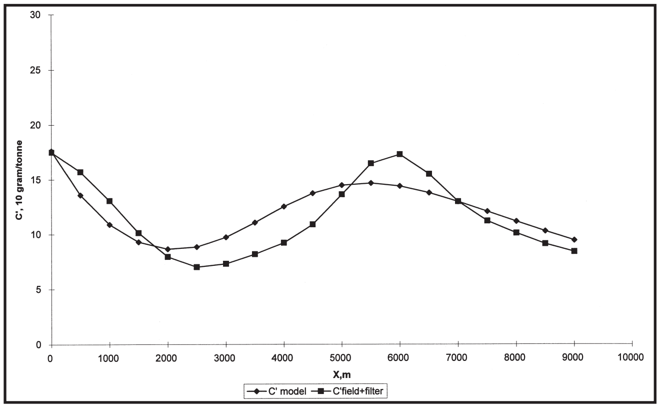
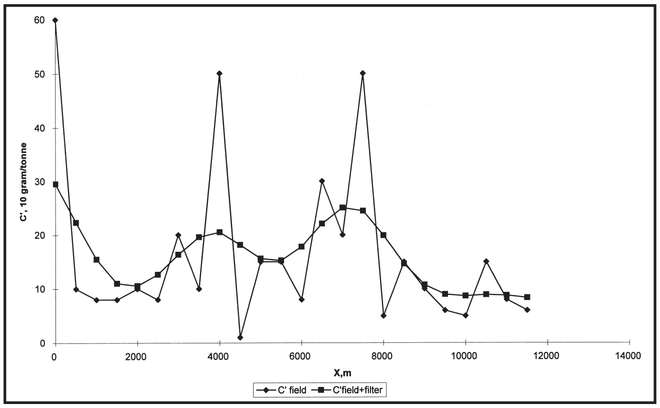


Figure 6b. Smoothed field vs. modeled concentration of tin in artificial spit placer 2 from Figure 2.



Figures 6a. Original field and smoothed (filtered) field concentrations of tin in artificial spit placer 2 from Figure 2.

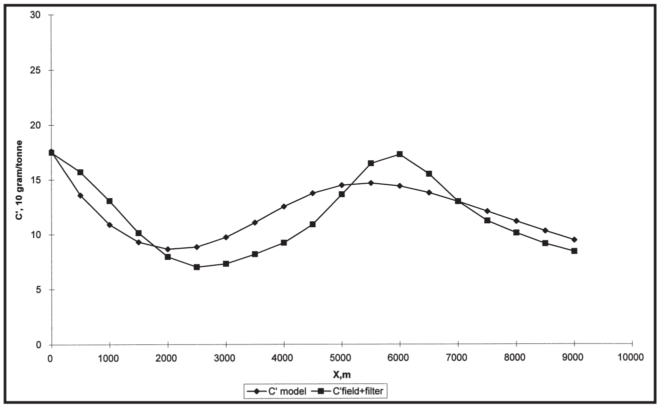
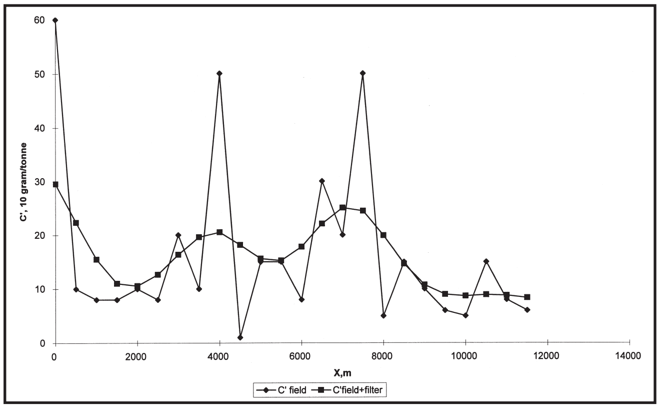


Figure 6b. Smoothed field vs. modeled concentration of tin in artificial spit placer 2 from Figure 2.

age of placer deposits. By using the known age of the APD (30 to 40 years), we were able to apply the model to predict the ages of natural spit placer deposits. Before this calculation can be made, it is necessary to correlate the volumes of tin-bearing sediments generated by ODG to those generated by natural processes of erosion. We estimated the volume of natural tin-bearing sediment loads for each researched stream as ranging between 1000 and 5000 m^3 per year with a present-day denudation rate average of 1 mm/year (Lalomov and Tabolitch, 1996a). The



Figures 7a. Original field and smoothed (filtered) field concentrations of tin in artificial spit placer 3 from Figure 2.

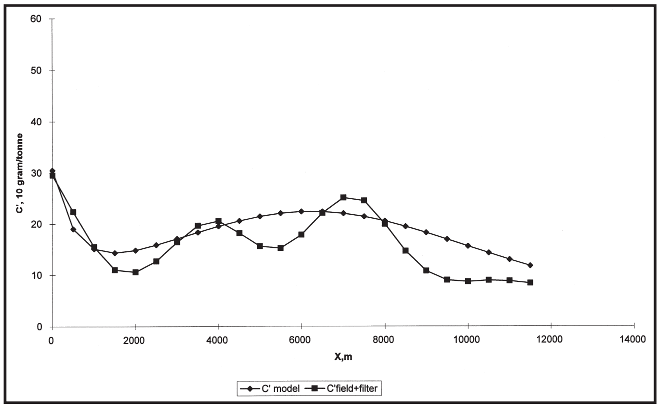
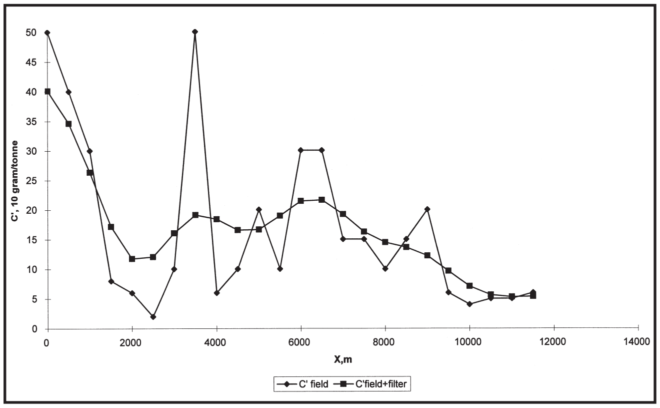


Figure 7b. Smoothed field vs. modeled concentration of tin in artificial spit placer 3 from Figure 2.



Figures 8a. Original field and smoothed (filtered) field concentrations of tin in artificial spit placer 4 from Figure 2.

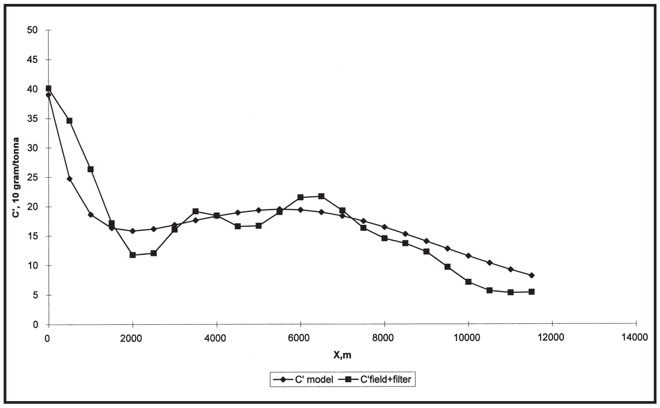
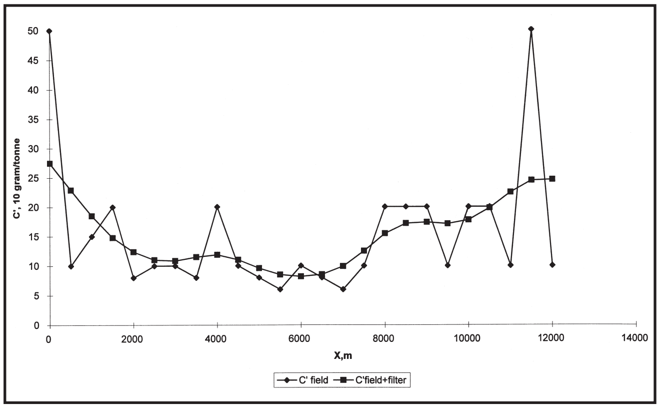


Figure 8b. Smoothed field vs. modeled concentration of tin in artificial spit placer 4 from Figure 2.



Figures 9a. Original field and smoothed (filtered) field concentrations of tin in artificial spit placer 5 from Figure 2.

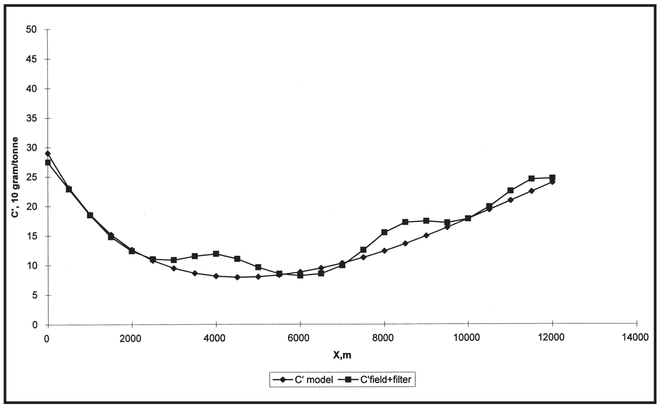


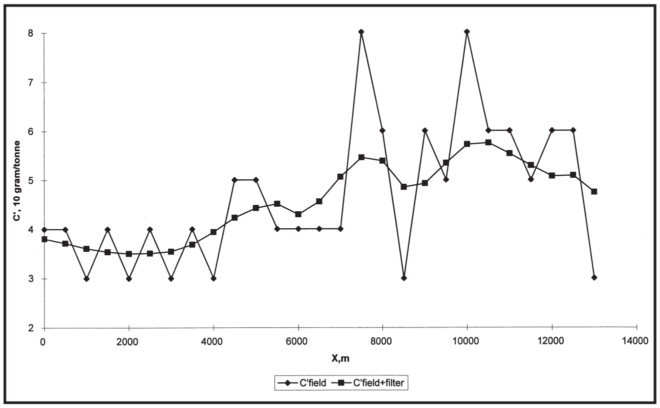
Figure 9b. Smoothed field vs. modeled concentration of tin in artificial spit placer 5 from Figure 2.

additional volume of the tin-bearing sediment loads derived from ODG wastage was estimated to range between 100,000 and 200,000 m^3 per year.

Thus, the volume of artificially-induced tin-bearing sediments introduced into the streams at the ODG sites from mining activity (M_a) is 20–200 times greater than that volume derived from natural processes (M_n). Hence, we can conclude that:

$$M_a = C_a V_a$$

$$M_n = C_n V_n$$



Figures 10a. Original field and smoothed (filtered) field concentrations of tin in natural spit placer 6 (Guravlini River) from Figure 2.

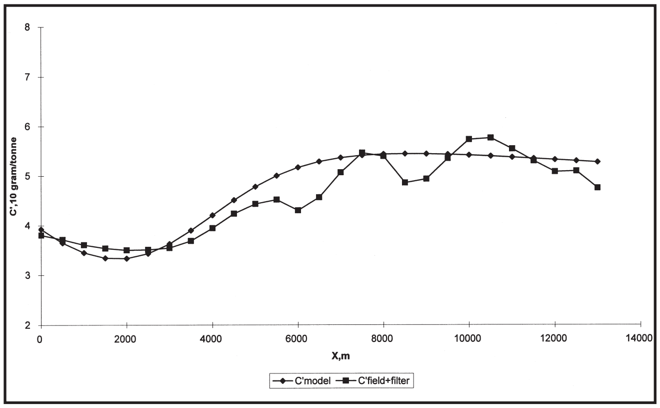


Figure 10b. Smoothed field vs. modeled concentration of tin in natural spit placer 6 (Guravlini River) from Figure 2.

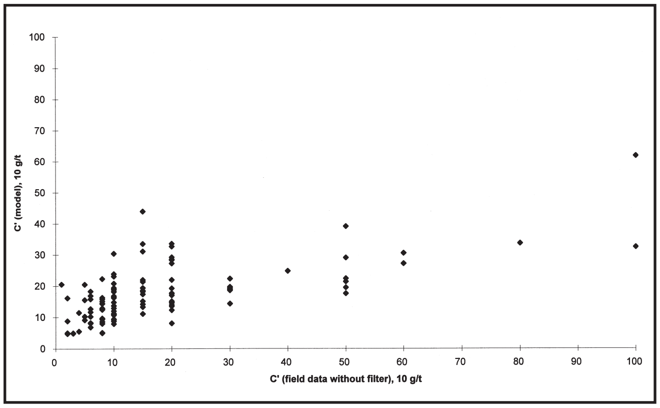


Figure 11. Correlation between original field and model data.

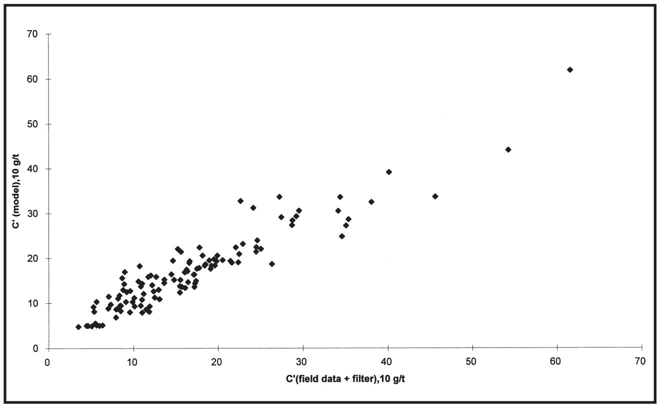


Figure 12. Correlation between smoothed field and model data.

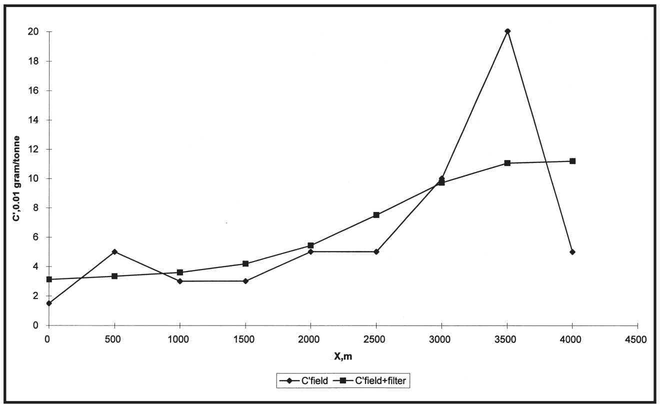


Figure 13a. Original field and smoothed (filtered) field concentrations of gold in the natural spit placer (Placer 6 in Figure 2).

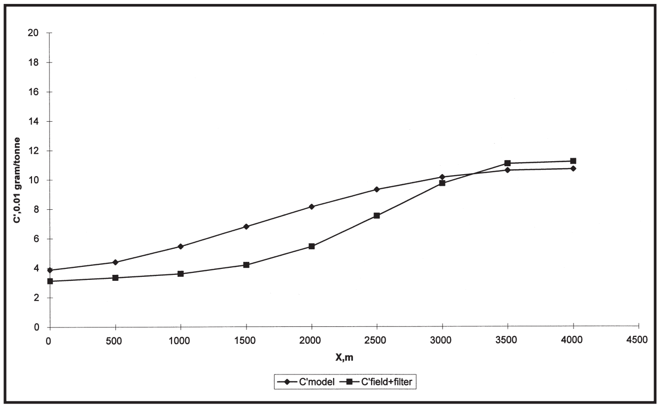


Figure 13b. Smoothed field vs. modeled concentration of gold in the natural spit placer (Placer 6 in Figure 2).

where C_a and C_n are artificial and natural cassiterite concentrations in the sediments, respectively. Therefore, if the concentration of cassiterite in the mines' trains and in the naturally-eroded slope sediments is the same, the difference between the volumes of artificial and natural transport of the cassiterite is:

$$\text{minimum} - \frac{100{,}000\ \text{m}^3\ \text{per year}}{1{,}000\ \text{m}^3\ \text{per year}} = 200\ \text{times}$$

$$\text{maximum} - \frac{200{,}000\ \text{m}^3\ \text{per year}}{1{,}000\ \text{m}^3\ \text{per year}} = 200\ \text{times}$$

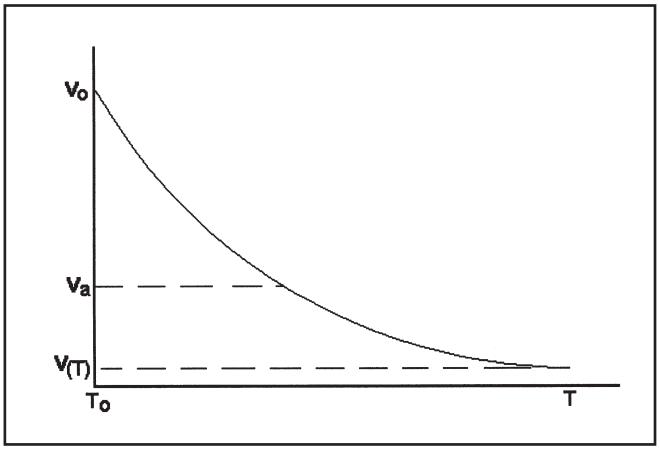


Figure 14. Graph showing method of calculation of post-Flood initial denudation rate.

Hence, the time span for artificial spit placer generation is 20–200 times less than that required for the equivalent formation of natural spit placer deposits. The process of placer generation is the same for both naturally and artificially-induced cassiterite in the stream sediments (since the physical properties of the cassiterite sediments are the same). Since the observed age of APD is 30–40 years; the time span for natural spit placer generation is:

Minimum: 30 years x 20 = 600 years;

Maximum: 40 years x 200 = 8000 years.

Therefore, if the rate of sediment loading into the stream is constant (implying a constant rate of landscape erosion), the time span for natural spit placer generation in similar streams (sharp gradient transition from mountainous to plain topography) is between 600 to 8000 years. This approximation is much less than the current uniformitarian estimate of one million years based on biostratigraphic methods.

If the axiom of uniformitarianism is rejected, then we may assume that the rate and intensity of denudation were higher in the past, immediately after the Flood (Nevins, 1974), decreasing from an unknown high magnitude to the present-day lower one (Reed, Froede and Bennett, 1996). Therefore, the real age of the placers may be even less than calculated above.

The model also allows an approximation of both initial and average denudation rates during post-Flood time for the Chaun region in northeastern Russia (Figure 1). A uniform extrapolation of present-day denudation rates produces an estimated age of 40,000 years for the Chaun depression (Lalomov and Tabolitch, 1996b). However, if the axiom of uniformitarianism is rejected, we can use the age of the Flood (4600 to 10,000 years based on the literal addition of the Genesis chronologies (Niessen, 1982) to calculate denudation rates. Thus, we may assume that the average post-Flood denudation rate (v_a) for the Chaun region was from 4 to 9 times greater than the present-day rate of 1 mm/year (Figure 14). Therefore, the real age of natural spit placers has been estimated to range between:

minimum – 600 years / 9 = 66 years; and

maximum – 8000 years / 4 = 2000 years.

To calculate the initial post-Flood denudation rate for northeastern Russia, we assume that the energy of geological processes (a surrogate for denudation rate) was exponentially decreasing after the Flood (Oard, 1996). This allows use of the following equation:

$$v_a = \frac{\int_0^T v_o \exp(-\beta T)dt}{T} \qquad (20)$$

where:

v_a = average post-Flood denudation rate;
v_o = initial post-Flood denudation rate;
β = the constant coefficient for the region;
T = age of the Flood (based on literal addition of Genesis chronologies).

We then can solve equation (20) and obtain:

$$v_o = \frac{v_a \beta T}{1-\exp(-\beta T)} \qquad (21)$$

We can define v_o using our assumption of exponential decrease of geological energy:

$$v_o = v_{(T)} \exp(\beta T) \qquad (22)$$

where $v_{(T)}$ = present-day rate of denudation (1 mm/year or 1m/1000 years).

From (21) and (22) we obtain:

$$\frac{\beta}{\exp(\beta T)-1} = \frac{v_{(T)}}{v_a T} \qquad (23)$$

Then we solve equation (23) for β numerically, substitute β into equation (22)and solve for v_o for the two given ages of the Flood (Table I):

Table I. Determination of Post-Flood Initial Denudation Rate for the Chaun Region.

T (thousand years)	$v_{(T)}$ (m/1000 years)	v_a (m/1000	β	$v_o = v_{(T)} \exp(\beta T)$ (m/1000 years)
4.6	1	9	0.755	32
10	1	4	0.2335	10

Our model can thus approximate the post-Flood initial denudation rate for northeastern Russia. We calculated a rate based on present-day denudation $v_{(T)}$, which was estimated for a large region. The difference between the calculated initial rates (up to 32 m/1000 years) and a flat-rate extrapolation (1 m/1000 years), illustrates the difference between uniformitarian and catastrophist assumptions. Of course, local rates may have varied significantly, and our calculation is only a regional approximation. Nevertheless, we believe that the method is valid for estimating the initial rate of post-Flood denudation.

Conclusions

We have presented a mathematical model for the generation of "far transfer" placers that successfully predicts the distribution of heavy minerals in alluvial placer deposits in northeastern Russia. The model implies that spit placer formation can occur in a relatively brief time.

The model shows that the process of natural "far transfer" placer generation is similar to the formation of artificial spit placers downstream from the cassiterite ore processing plants using ore dressing gears. Knowing the time for artificial placer deposit formation allows us to model the time interval for natural placer generation.

"Far transfer" placer deposits in northeastern Russia were modeled as developing in less than 2000 years. This maximum estimate is approximately 500 times less than the age prediction based on the standard geologic timescale. Our model predicts that the true rate of formation of alluvial "far transfer" placer deposits formation is dramatically greater than that assumed by uniformitarian geologists.

Our model also allows a calculation of the initial post-Flood denudation rate for the study area. The average initial rate for the Chaun region is predicted to range between 10 and 32 times greater than the present rate, depending on the associated age of the Flood.

We believe that our model not only is an interesting exercise in the application of the Flood model to geological problems, but that it also has enormous practical importance for predicting the commercial potential and location of natural and artificial spit placer deposits. We intend to continue our investigations of alluvial stream and slope deposits age.

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Book Review

Origins: Linking Science and Scripture by Ariel A. Roth
Review and Herald Publishing Association. 1998. 384 pages, $30
Available from Spring Arbor, 10885 Textile Road, Believille MI 48111
Reviewed by Wayne Frair, Ph.D.

Here is a clearly-written comprehensive non-dogmatic work of value for a person in early or advanced stages of learning about important creation/evolution issues. Author Dr. Roth, who is a professional biologist, has had years of experience in science as a professor with graduate students, and as editor of the respected scholarly journal, *Origins*. Roth's book deserves a place in suitable classrooms and on shelves of public and private libraries.

Matters covered include pertinent early and recent history, and "putting it all together"(3 chapters); life—biochemistry through anthropology (5 chapters); geology—fossils, catastrophies (including the Flood), and time (7 chapters); an evaluation of science, truth, and the Bible (4 chapters); some conclusions—condition of science, evaluations of 8 major models relating the Bible and science, and a recapitulation (3 chapters). The 22 chapters are relatively short (average 15 pages including references), and each has a respectable list of references (average of 42 references/chapter). There is a 7-page Glossary and 13-page Index.

This book has been carefully researched, written and proofread. However, I did notice errors with the Latin singular and plural (*lamina*, p. 250; *alga*, p. 314). It is becoming more acceptable with Latin words to anglicize plurals, for example formula to formulas (rather than formulae). *Origins* was published in December 1998, but most references are older than 1996.

It was refreshing to encounter the candor demonstrated by Roth as he wrestled with crucial issues in the ongoing tension between scientific and religions sectors. Macroevolution came out a loser, but where there are no easy answers he acknowledged this, and there was no rancor toward his opponents. Roth challenges the current geological time scale and stresses his Bible-based view that creation occurred less than 10,000 years ago. He really does not believe that any other position is "creationist", but he deigns to submit that "little in the Bible precludes a very old universe" (p. 233–234). In the extensive geology section he suggests that the Genesis Flood deposits began in the Cambrian and ended in the upper Tertiary. There were, he speculates, rapid plate movements especially during later stages of the Flood, and ice ages were post-Flood. Sedimentary layers probably were deposited rapidly.

Roth realizes that science needs a good revamping. The nature of science: is finding truth and explanations about nature (p. 286). Science often prides itself on being open and objective, but evolution brings into question both attributes. How did science get into the conundrum of defending an idea for which there is little support and for which one finds major scientific problems (p. 333). Science made its greatest error when it rejected God and everything else except mechanistic explanations (p. 334). Science should return more toward the philosophy it had when Western Civilization established sciences's foundations (p. 136).

Roth does not understand that the Bible and science are to be construed in opposition. He has written this book to harmonize them, and he encourages others to do the same.