Gold Placers in Earth History

ALEXANDER V. LALOMOV AND SERGUEI E. TABOLITCH

ABSTRACT

The distribution of gold placers within the lithostratigraphic column is evidence of the accuracy of the Biblical framework of Earth history. It also confirms the appropriateness of interpreting stratigraphic records on the basis of a correlation between geological energy and the sequence and nature of the events described in the early chapters of Genesis.

The placer distribution also gives information about the possible location of significant geological boundaries, such as the pre-Flood/Flood and Flood/post-Flood boundaries.

INTRODUCTION

Creationists reject the uniformitarian geologists' time-scale and many reject the validity of their global geological column. They have been developing their own interpretations of the stratigraphic record based on the assumption of the Biblical Christian worldview. One of the most useful methods for understanding the stratigraphic record from a creationist perspective is to examine the lithostratigraphic column on the basis of the principle of the energy of geological processes as they accord with the Biblical descriptions of the Creation Week and Genesis Flood.[1]

Placer generation (and gold placer generation in particular) is a good indicator of environmental conditions, because placer generation requires the combination of many different processes.[2] Therefore, it is appropriate for any speculative model of Earth history to be tested against the actual distribution of placers within the sedimentary sequence.

All gold deposits may be divided into two types: primary (lodes, veins and zones of mineralisation generated by magmatic and hydrothermal processes) and placers.

The term 'placer', probably of Spanish derivation, is typically applied to gold deposits in stream sands and gravels. Today we define a placer as a deposit of sand, gravel and other detrital or residual material containing a valuable heavy mineral that has accumulated through weathering and mechanical concentration.

The immediate source of a placer is from primary deposits, and (or) from pre-existing placer deposits. However, all placers are ultimately derived from primary deposits. Placers appear to have formed after tectonic activity and erosional processes when conditions in watery environments (such as in streams or on coastal shelves) allow the steady separation and concentration of heavy mineral-bearing clastic sediments. Placer gold deposits typically result from weathering and release of gold from primary lode deposits, transportation of the gold and concentration of the gold dominantly in gravely, pebbley and bouldery sediments of streams.

Our previous investigation showed that placers may form in a short time, under catastrophic conditions.[3] In this paper we use these results for research of placer distribution within the sedimentary sequence.

STREAM SEDIMENT PLACERS

The equations (1) and (2) estimate the concentration of the heavy mineral cassiterite (tin oxide) in coastal submarine placers under lateral coastal drift conditions. It is probable that the equations for tin and gold placers in streams will have some variance from these equations for coastal placers, but the general principles should be the same for both types of environments. Therefore we will, for the moment, use these same equations for a qualitative estimation of heavy mineral distribution in stream conditions.

$$C_{(X)} = KC_p(1-(X_O/X)^A) \text{ for segment } X_O<X<X_1 \quad (1)$$

$$C_{(X)} = KC_p(X_1^A - X_O^A)/X^A \text{ for segment } X>X_1 \quad (2)$$

where:

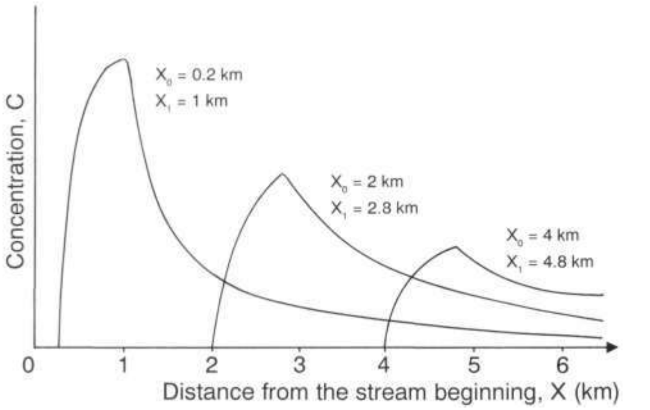

Figure 1. *Mathematical modelling of heavy mineral concentration (C) for different distances from stream beginning to the source of heavy minerals.*

$C_{(X)}$ — concentration of heavy minerals in the placer at a point at distance X from the source of the stream;
C — average concentration of heavy minerals in the incoming ore-bearing material;
X_0, X_1 — point locations defining the limits of the zone of the heavy mineral source;
K — coefficient determining the composition of the source;
A — coefficient determining the intensity of hydrodynamic activity.

The influence of the parameters X_0, X_1 and A upon heavy mineral concentration can be seen in Figures 1 and 2. Figure 1 shows the influence of the location of the heavy mineral source. If the heavy mineral source is far from the stream beginning, the maximum possible heavy mineral concentration is much reduced. For example, in the case of the Val'cumey tin placer (north-eastern Russia), the tin lode deposit is almost near the source of lateral coastal drift (X_0 = 200 m, X_1 = 1200 m), therefore there is a rich tin placer here. If the tin lode was located more than 6,000 m from the drift source, the tin concentration might be much reduced and the placer would not be expected to have economic importance.

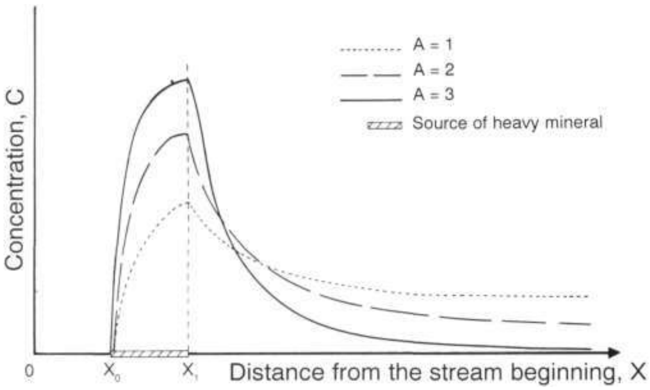

Figure 2. *Mathematical modelling of heavy mineral concentration (C) for different values of coefficient A.*

In other words, the accumulation environment must be located not far from the erosional environment. It is very difficult to imagine this situation developing in the conditions of a very powerful and energetic process, such as the Genesis Flood. If we suppose that the scope of a geological process depends on its energy, then periods of moderate geological energy will be more favourable for placer formation. According to Walker's Biblical geological model,[4] local scale geological structures (not more than 10 km^2) would be expected during the Lost World Era (between Creation Week and the Flood) and during the Dispersive phase (the latest) of the Flood event, and later during the New World Era. Therefore, these periods would have been the most favourable for placer generation because of the short distances between different geological structures and feasible environments of erosion and accumulation.

Figure 2 shows the dependence of concentration upon hydrodynamic activity. Stream placers have formed within narrow hydrodynamic conditions. In general outline, the upper limit of hydrodynamic activity corresponds with the lowest velocity required for coarse heavy mineral grain movement. The lower limit of hydrodynamic activity for placer generation corresponds to a critical value of velocity required for the transport of the finest grains of clastic sediments only, such as silt and clay. A high value for coefficient 'A' corresponds to high hydrodynamic activity. A low value for 'A' (and hydrodynamic activity) is not favourable for high concentration of heavy minerals, because of the weakness of the concentration process. High activity is most favourable for placer generation, but if the stream velocity is higher than the critical velocity for the movement of the larger heavy mineral grains, then all clastic material becomes a suspension, and a placer will form only after stream velocity decreases below that critical velocity. We can see examples of both limits in present-day situations. The upper limit for placer formation is observed in a mud-flow, in which minerals with different specific gravity are transported without any separation or concentration.[5] The lower limit is near the velocity of present-day rivers in transitional zones between mountains and plains.

DISTRIBUTION OF PLACERS IN THE LITHOSTRATIGRAPHIC COLUMN

Reed, Froede and Bennett[6] proposed a geologic energy versus time plot based on Scriptural interpretation (simplified in Figure 3). They focussed on a more general 'geologic energy', without differentiation into tectonic and hydraulic components. We propose that, in general, a qualitative purely hydrodynamic energy graph will have a similar shape.

We must also take into consideration that the energy versus time line of Figure 3 is only an average line for natural processes. Really, it is a wide band because of the high dispersion or scatter of parameters at different points on

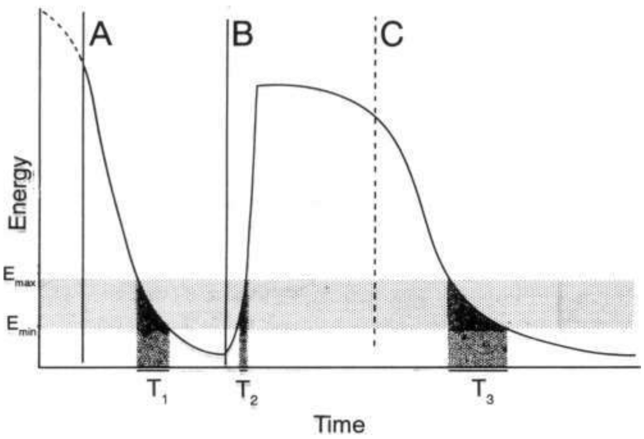

Figure 3. *Proposed hydrodynamic energy versus time plot based on Scriptural interpretation (from Reed, Froede and Bennett, 1996, with some simplifications and additions by us). Key geologically significant dividing lines A, B and C mark the third day of creation, the onset of the Genesis Flood, and the initiation of a steady energy decrease marking the post-Flood to the present respectively. E_{MAX} and E_{MIN} mark the interval of the energy value most favourable for placer formation. T_1, T_2 and T_3 mark the most favourable times for placer generation. All the plot data are qualitative.*

the Earth's surface. A high energy turbulent stream is a very inhomogeneous medium, hence there may be local temporary zones of low hydrodynamic rate within the generally high energy environment.[6] Therefore, at any moment of Earth history we could find different hydrodynamic conditions. Even today we see very different hydrodynamic conditions ranging from mud-flows in the Himalayas and tsunami in Japan to stagnant swamps of Florida. Consequently, placers could form in almost every time-span, but it is apparent from the lithostratigraphic record that only some periods had **widespread** conditions favourable for placer generation.

According to the Bible's record of Earth history there should have been two periods most suitable for placer generation. Both periods were characterised by a stage of steadily decreasing hydrodynamic energy. The first one followed the third day of creation, and the second one was in the waning stage of the Genesis Flood (T_1 and T_3, Figure 3). The **duration** of these periods of declining hydrodynamic energy would not have influenced the placer generation process. Placers may be generated without requiring a long time interval, because concentration of heavy minerals occurs as soon as lateral coastal drift or stream sediment movement commences.[8] For example, the time-span for generating deposits up to 2 m thick within an active layer in the Val'cumey tin placer deposits (Chaun Bay, East-Siberian Sea, north-eastern Russia) is estimated to be 80 days, when the length of the placer is 8,000m and the sediment drift velocity was 100 m per 24 hours. In the case of higher energy processes the duration of placer formation may be much less if the flow rate is not too high for placer formation.

The period T_2 (see Figure 3) is not considered favourable for placer formation because erosion would have prevailed over sedimentation during the stage of increasing hydrodynamic activity at the beginning of the Flood. It is unlikely, therefore, that placers from this stage would have survived.

Thus, we argue that there were only two periods favourable for placer generation during Earth history, and that this is what we might expect to find in the geological record.

Uniformitarian theory assumes that there were many periods of tectonic and magmatic activity with mountain-building throughout Earth history. In sedimentary sequences these periods are divided by unconformity boundaries. Unconformities are understood as erosive horizons, dividing sedimentary sequences made up of **concordant** layers. Creationist geologists also recognise the existence of unconformities in the stratigraphic record. Davison states that

> *'they indicate regionally (or globally)-controlled tectonic or other activity which controlled sedimentation during the Flood'.*[9]

Many aspects of modern theoretical and applied geology depend on the way unconformities are understood. According to uniformitarian theory, unconformities form after a phase of intensive tectonic movement, commonly accompanied by ore lode emplacement and mountain-building. The denudation process forms a thick sequence of overlying conformable clastic deposits which contain large amounts of heavy minerals in low concentrations. New placers are generated by concentration of the heavy minerals through the action of water on these sediments.[10] There are many unconformity boundaries in the lithostratigraphic column. Therefore, according to uniformitarian theory, placers might be expected to occur frequently and evenly within the lithostratigraphic column. These comments apply to any heavy minerals, but are most clearly applicable to gold placers.

PLACER GOLD

It is beyond the scope of this paper to enumerate all investigations about the genesis and distribution of placer gold deposits. One of the most complete and interesting publications based on uniformitarian theory is a recent monograph of Bache.[11] He notes that

> *'. . . the ancient placers. . . are widely distributed and are of very variable age from Archaean Era to Triassic Period.... of these old placers only those of Archaean to Proterozoic age are of economic interest and are worked now'.*

Bache's data show detrital deposits represent 67.5 per cent of the world's known gold-bearing deposits. Archaean to Proterozoic placers contain almost 58 per cent of total world gold (86 per cent of total gold-bearing placer deposits). For example, the Late Archaean Witwatersrand (South Africa) deposit alone has contributed about 30 per cent of the total gold estimated to have been mined in the entire history of mankind. Young and recent alluvial, beach and eluvial placers also make a considerable contribution with 8.9 per cent of worked gold (13 per cent of total gold-bearing placer deposits). The largest part of this gold is located in Palaeogene and Neogene deposits. However, all sedimentary sequences between the Middle Proterozoic and Tertiary contain only 0.6 per cent of known gold deposits (about 1 per cent of total gold-bearing placer deposits)! Hence, it is readily apparent that the distribution of gold placers in the sedimentary sequence is concentrated into two segments of geological time (see Figure 4). Such a distribution is very difficult to explain in terms of uniformitarian theory, but is consistent with the Biblical model proposed above.

MAIN BOUNDARIES IN BIBLICAL EARTH HISTORY

The knowledge of placer generation processes and placer distribution may also help define some key geological boundaries, such as pre-Flood/Flood and Flood/post-Flood boundaries.

The main principles of the uniformitarian geological column construction are faulty.[12,13] Therefore, we can recognise the existence of local geological columns only. It is very debatable that any uniformitarian geological boundary is simultaneously generated everywhere in the world.[14] Therefore, creationists have had to work out their own criteria for sediment correlation. Complex criteria should be more effective than a single criterion. A good example of the application of complex criteria is the determination of Great Artesian Basin sediments as being deposited during Walker's Zenithic phase of the Flood.[15]

We propose placer distribution within the sedimentary sequence as a useful addition to the criteria for determining the age of sedimentary deposits.

Creationist geologists have debated about the location of the pre-Flood/Flood boundary in the lithostratigraphic column. Austin and Wise placed the boundary at the base of Cambrian strata,[16] or at the base of the Vendian (late Upper Proterozoic).[17] Snelling proposed that the boundary corresponds with the Middle Archaean.[18] Hunter placed the boundary deep into the mantle.[19] Considering the graph of geological processes based on Biblical data in Figure 3 and conditions considered most suitable for placer formation, we can conclude that the first period of extensive placer generation was at the time of decreasing hydrodynamic energy after the Third Day of Creation Week. Therefore, in the case of South Africa, the location of the Witwatersrand gold placer, we may assume that the pre-Flood/Flood boundary is situated at a stratigraphic level not lower than the Witwatersrand Supergroup (late Archaean). The same conclusion can probably be drawn for other ancient gold placers, such as Tarkwa in Ghana, Jacobina in Brazil, and Elliot Lake, Blind River in Canada.

A significant argument for the existence of placer gold before the Flood comes from the Bible itself:

> 'A river watering the garden flowed from Eden; from there it was separated into four headwaters. The name of the first is the Pishon; it winds through the entire land of Havilah, **where there is gold. (The gold of that land is good;** aromatic resin and onyx are also there)...'. Genesis 2:10-12 (NIV).

Gold was known to people from very ancient times. *'The history of gold is a long one, going back to the dawn of civilization.'*[20] It is the first metal (and mineral deposit) to be mentioned in the Bible. But what form of gold, especially, is referred to in Genesis 2:10-12?

We believe that the first gold known to man was placer gold. It was the easiest to find and extract, and placer gold is relatively free of contaminants. Placers are still significantly important to the gold mining industry. They

> *'account for more than two-thirds of total world gold supply, and roughly half of that mined in the States of California, Alaska, Montana and Idaho.'*[21]

In fact, it was only from the beginning of the twentieth century that primary gold deposits became important to the mining industry.[22] Yeend and Shawe also suggest that: *'Man most likely first obtained gold from placer deposits'.*[23] Boyle also seems convinced that

> *'The principle source of gold in primitive times was undoubtedly stream placers'*

and that

> *'The statement in Genesis that the gold was "good", probably meaning relatively pure, suggests a placer source for the metal.'*[24]

Therefore, we think it likely that the gold mentioned in Genesis 2:10-12 represents the Precambrian gold placers, and that these are pre-Flood deposits. In the uniformitarian geological column all Precambrian placers (Witwatersrand

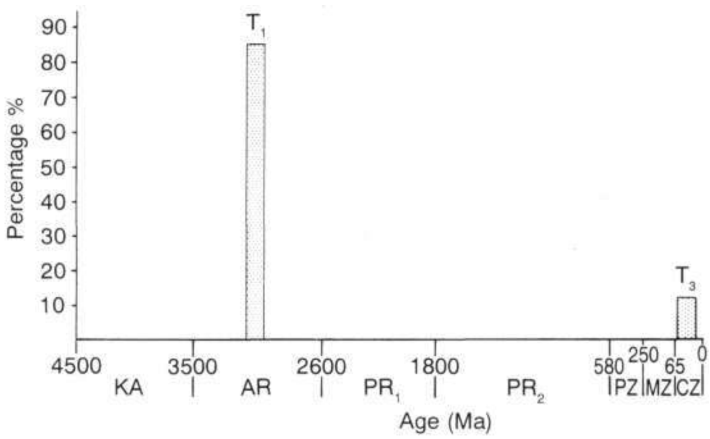

Figure 4. *Placer generation during Earth history (according to the uniformitarian geological time-scale) in per cent of total gold-bearing placer deposits. KA — Katarchaean, AR—Archaean, PR_1 — Lower Proterozoic, PR_2 — Upper Proterozoic, PZ—Palaeozoic, MZ—Mesozoic, CZ—Cainozoic; T_1 and T_3 — most favourable times for placer generation from Figure 3.*

in South Africa, Tarkwa in Ghana, Jacobina in Brazil and Elliot Lake, Blind River in Canada) are considered to be of Archaean age. Hence, we propose that these deposits have a pre-Flood origin.

We also propose that the younger period of placer concentration in the Cainozoic is related to decreasing hydrodynamic activity after the Flood. Our mathematical modelling of placer generation shows that the process could have begun about 4,000 years ago.[25] Hence, it is proposed that the Flood/post-Flood boundary is located between the uniformitarian Upper Cretaceous and Palaeocene strata.

These conclusions may be debated, but we hope that creationists will take into consideration the possible constraint which placer distribution may place on the determination of sediment age within the Biblical framework.

CONCLUSIONS

Because the main principles undergirding the uniformitarian geological column are faulty, creationists need to use new criteria for stratigraphic correlation and interpretation of the geological data. It seems to us that the concept of the distribution of geological process energy in Earth history is potentially one of the most useful of such criteria.

The information presented in the Bible and the understanding of conditions required for placer generation, let us predict the existence of two periods of extensive placer development within the sedimentary sequence. Uniformitarian theory would predict that placers should be located evenly throughout time. Field investigations show that extensive formation of gold placers was restricted to only two periods of Earth history. Therefore, it is concluded that the distribution of gold placers within the lithostratigraphic column is in fact evidence of the validity of the Biblical framework of Earth history.

The placer distribution also gives information about the locations of significant Biblical geological boundaries. It allows us to propose that the Precambrian gold placers are pre-Flood deposits. We also propose that mass-scale generation of placers in Cainozoic strata is evidence that these deposits formed after the peak of the Genesis Flood.

ACKNOWLEDGMENTS

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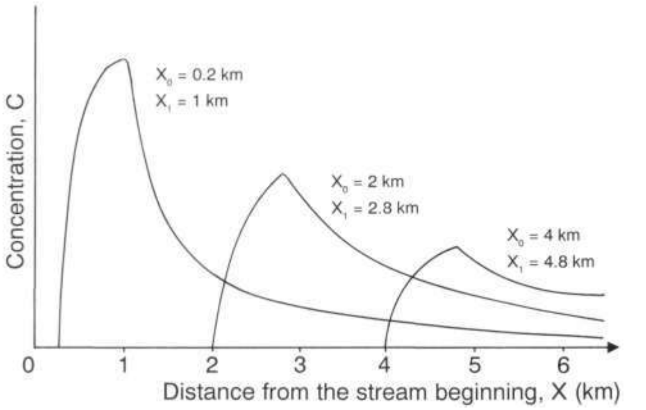
REFERENCES

1. Reed, J. K., Froede, C. R., Jr and Bennett, C. B., 1996. The role of geologic energy in interpreting the stratigraphic record. **Creation Research Society Quarterly,** 33(2)97-101.
2. Wells, J. H., 1969. Placer examination — Principles and practice. U.S. **Bureau of Land Management, Technical Bulletin 4,** 155 pp.
3. Lalomov, A. V and Tabolitch, S. E., 1996. Catastrophism and modern geology: modelling the placer generation process. **Creation Research Society Quarterly,** 33(3): 186-190.
4. Walker, T. B., 1996. The Great Artesian Basin, Australia. CEN **Tech.** J.,10(3):379-390,Table 2.
5. Osovetsky, B. M., 1986. **Heavy Minerals of Sediments** (in Russian), Irkutsk University Publishers, Irkutsk, USSR, 250 pp.
6. Reed *et al.*, Ref. 1.
7. Graf, W. H, 1971. **Hydraulics of Sediment Transport,** McGraw-Hill, New York, 513 pp.
8. Lalomov and Tabolitch, Ref. 3.
9. Davison, G. E., 1995. The importance of unconformity-bounded sequences in Flood stratigraphy. **CEN Tech. J.,** 9(2):223-243.
10. Wells, Ref. 2.
11. Bache, J. J, 1987. **World Gold Deposits: A Geological Classification,** North Oxford Academic Publishers Ltd, London, p. 117.
12. Reed, J. K., 1996. A Biblical Christian framework for Earth history research. Part 1 — Critique of the naturalist-uniformitarian system. **Creation Research Society Quarterly,** 33(1):6-12.
13. Morris, H. M., 1996. The geologic column and the Flood of Genesis. **Creation Research Society Quarterly,** 33(l):49-57.
14. Snelling,A. A., 1991. Creationist geology: where do the 'Precambrian' strata fit? **CEN Tech. J.,** 5(2): 154-175.
15. Walker, Ref. 4.
16. Austin, S. A. and Wise, K. P., 1994. The pre-Flood/Flood boundary: as defined in Grand Canyon, Arizona and Eastern Mojave Desert, California. *In:* **Proceedings of the Third International Conference on Creationism,** R.E. Walsh (ed.), Creation Science Fellowship, Pittsburgh, Pennsylvania, pp. 37-47.
17. Wise, K. P., 1992. Some thoughts on the Precambrian fossil record. CEN Tech.J.,6(l):67-71.
18. Snelling,Ref. 14.
19. Hunter, M. J., 1996. Is the pre-Flood/Flood boundary in the Earth's mantle? **CEN Tech. J.,** 10(3):344-357.
20. Boyle, R. W, 1987. **Gold: History of Genesis of Deposits,** Van Nostrand Reinhold, New York, p. xiii.
21. Yeend, W. and Shawe, D. R., 1989. Gold in placer deposits. **U.S. Geological Survey, Bulletin 1857-G,** p. 1.
22. Ajgirey, G. D., Breshenkova, B. K., Prokofieva, A. P. and Rusinova, L. A., 1954. **Methods of Search and Prospecting of Mineral Deposits** (in Russian), Nedra Publishers, Moscow, USSR, 463 pp.
23. Yeend, Ref. 21, p. 1.
24. Boyle, Ref. 20, pp. 23,25.
25. Lalomov, A. V. and Tabolitch, S. E., 1996. Catastrophism in geology: determination of the generation time of coastal submarine placers based on mathematical modelling. CEN Tech. J., 10(3):373-378.

Dr Alexander V. Lalomov is a sedimentologist who graduated from Leningrad State University in 1982, and then worked in the Russian Arctic until 1990 as a senior geologist prospecting for gold and tin placers. In 1992 he defended his Ph.D. thesis on the mathematical modelling of placer generation.

Serguei E. Tabolitch is a geochemist who graduated from Moscow State University in 1983, and then also worked in the Russian Arctic until 1990 as a senior geologist in geochemistry, similarly prospecting for gold and tin placers. Both Serguei and Alexander are members of the Moscow Creation Science Fellowship.



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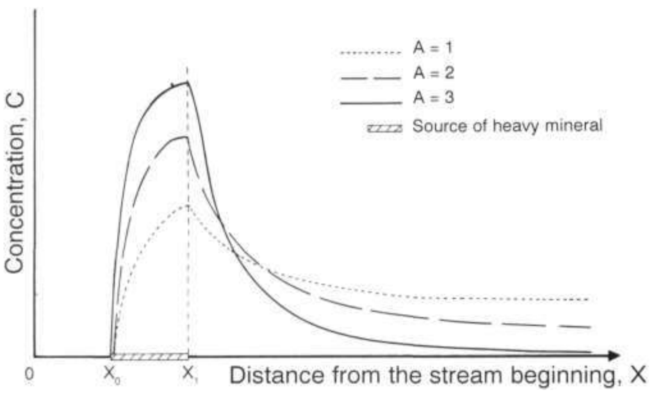

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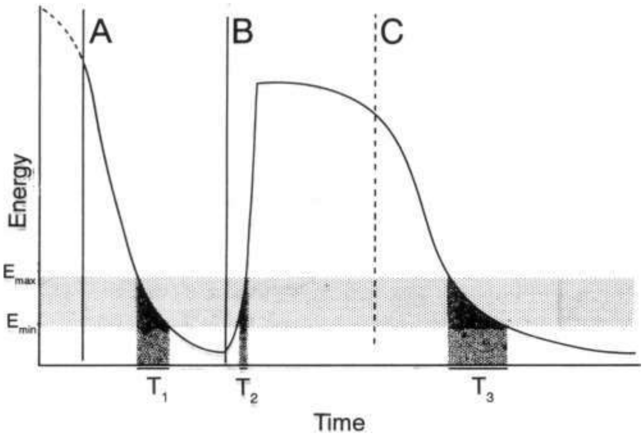

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It is beyond the scope of this paper to enumerate all investigations about the genesis and distribution of placer gold deposits. One of the most complete and interesting publications based on uniformitarian theory is a recent monograph of Bache.[11] He notes that

> *'. . . the ancient placers. . . are widely distributed and are of very variable age from Archaean Era to Triassic Period.... of these old placers only those of Archaean to Proterozoic age are of economic interest and are worked now'.*

Bache's data show detrital deposits represent 67.5 per cent of the world's known gold-bearing deposits. Archaean to Proterozoic placers contain almost 58 per cent of total world gold (86 per cent of total gold-bearing placer deposits). For example, the Late Archaean Witwatersrand (South Africa) deposit alone has contributed about 30 per cent of the total gold estimated to have been mined in the entire history of mankind. Young and recent alluvial, beach and eluvial placers also make a considerable contribution with 8.9 per cent of worked gold (13 per cent of total gold-bearing placer deposits). The largest part of this gold is located in Palaeogene and Neogene deposits. However, all sedimentary sequences between the Middle Proterozoic and Tertiary contain only 0.6 per cent of known gold deposits (about 1 per cent of total gold-bearing placer deposits)! Hence, it is readily apparent that the distribution of gold placers in the sedimentary sequence is concentrated into two segments of geological time (see Figure 4). Such a distribution is very difficult to explain in terms of uniformitarian theory, but is consistent with the Biblical model proposed above.

MAIN BOUNDARIES IN BIBLICAL EARTH HISTORY

The knowledge of placer generation processes and placer distribution may also help define some key geological boundaries, such as pre-Flood/Flood and Flood/post-Flood boundaries.

The main principles of the uniformitarian geological column construction are faulty.[12,13] Therefore, we can recognise the existence of local geological columns only. It is very debatable that any uniformitarian geological boundary is simultaneously generated everywhere in the world.[14] Therefore, creationists have had to work out their own criteria for sediment correlation. Complex criteria should be more effective than a single criterion. A good example of the application of complex criteria is the determination of Great Artesian Basin sediments as being deposited during Walker's Zenithic phase of the Flood.[15]

We propose placer distribution within the sedimentary sequence as a useful addition to the criteria for determining the age of sedimentary deposits.

Creationist geologists have debated about the location of the pre-Flood/Flood boundary in the lithostratigraphic column. Austin and Wise placed the boundary at the base of Cambrian strata,[16] or at the base of the Vendian (late Upper Proterozoic).[17] Snelling proposed that the boundary corresponds with the Middle Archaean.[18] Hunter placed the boundary deep into the mantle.[19] Considering the graph of geological processes based on Biblical data in Figure 3 and conditions considered most suitable for placer formation, we can conclude that the first period of extensive placer generation was at the time of decreasing hydrodynamic energy after the Third Day of Creation Week. Therefore, in the case of South Africa, the location of the Witwatersrand gold placer, we may assume that the pre-Flood/Flood boundary is situated at a stratigraphic level not lower than the Witwatersrand Supergroup (late Archaean). The same conclusion can probably be drawn for other ancient gold placers, such as Tarkwa in Ghana, Jacobina in Brazil, and Elliot Lake, Blind River in Canada.

A significant argument for the existence of placer gold before the Flood comes from the Bible itself:

> 'A river watering the garden flowed from Eden; from there it was separated into four headwaters. The name of the first is the Pishon; it winds through the entire land of Havilah, **where there is gold. (The gold of that land is good;** aromatic resin and onyx are also there)...'. Genesis 2:10-12 (NIV).

Gold was known to people from very ancient times. *'The history of gold is a long one, going back to the dawn of civilization.'*[20] It is the first metal (and mineral deposit) to be mentioned in the Bible. But what form of gold, especially, is referred to in Genesis 2:10-12?

We believe that the first gold known to man was placer gold. It was the easiest to find and extract, and placer gold is relatively free of contaminants. Placers are still significantly important to the gold mining industry. They

> *'account for more than two-thirds of total world gold supply, and roughly half of that mined in the States of California, Alaska, Montana and Idaho.'*[21]

In fact, it was only from the beginning of the twentieth century that primary gold deposits became important to the mining industry.[22] Yeend and Shawe also suggest that: *'Man most likely first obtained gold from placer deposits'.*[23] Boyle also seems convinced that

> *'The principle source of gold in primitive times was undoubtedly stream placers'*

and that

> *'The statement in Genesis that the gold was "good", probably meaning relatively pure, suggests a placer source for the metal.'*[24]

Therefore, we think it likely that the gold mentioned in Genesis 2:10-12 represents the Precambrian gold placers, and that these are pre-Flood deposits. In the uniformitarian geological column all Precambrian placers (Witwatersrand

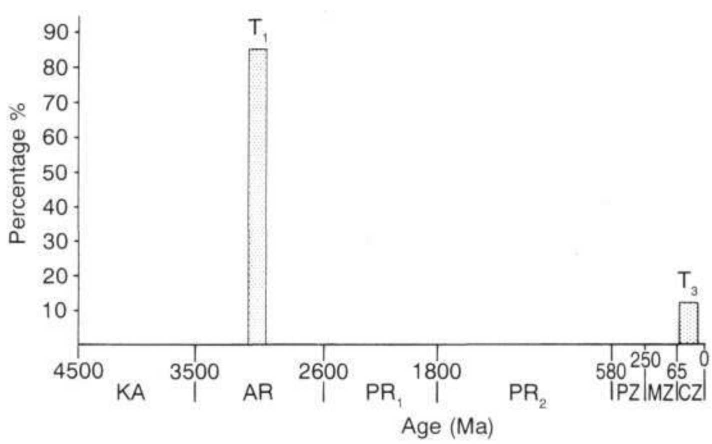

Figure 4. *Placer generation during Earth history (according to the uniformitarian geological time-scale) in per cent of total gold-bearing placer deposits. KA — Katarchaean, AR—Archaean, PR_1 — Lower Proterozoic, PR_2 — Upper Proterozoic, PZ— Palaeozoic, MZ— Mesozoic, CZ— Cainozoic; T_1 and T_3 — most favourable times for placer generation from Figure 3.*

in South Africa, Tarkwa in Ghana, Jacobina in Brazil and Elliot Lake, Blind River in Canada) are considered to be of Archaean age. Hence, we propose that these deposits have a pre-Flood origin.

We also propose that the younger period of placer concentration in the Cainozoic is related to decreasing hydrodynamic activity after the Flood. Our mathematical modelling of placer generation shows that the process could have begun about 4,000 years ago.[25] Hence, it is proposed that the Flood/post-Flood boundary is located between the uniformitarian Upper Cretaceous and Palaeocene strata.

These conclusions may be debated, but we hope that creationists will take into consideration the possible constraint which placer distribution may place on the determination of sediment age within the Biblical framework.

CONCLUSIONS

Because the main principles undergirding the uniformitarian geological column are faulty, creationists need to use new criteria for stratigraphic correlation and interpretation of the geological data. It seems to us that the concept of the distribution of geological process energy in Earth history is potentially one of the most useful of such criteria.

The information presented in the Bible and the understanding of conditions required for placer generation, let us predict the existence of two periods of extensive placer development within the sedimentary sequence. Uniformitarian theory would predict that placers should be located evenly throughout time. Field investigations show that extensive formation of gold placers was restricted to only two periods of Earth history. Therefore, it is concluded that the distribution of gold placers within the lithostratigraphic column is in fact evidence of the validity of the Biblical framework of Earth history.

The placer distribution also gives information about the locations of significant Biblical geological boundaries. It allows us to propose that the Precambrian gold placers are pre-Flood deposits. We also propose that mass-scale generation of placers in Cainozoic strata is evidence that these deposits formed after the peak of the Genesis Flood.

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REFERENCES

1. Reed, J. K., Froede, C. R., Jr and Bennett, C. B., 1996. The role of geologic energy in interpreting the stratigraphic record. **Creation Research Society Quarterly,** 33(2)97-101.
2. Wells, J. H., 1969. Placer examination — Principles and practice. U.S. **Bureau of Land Management, Technical Bulletin 4,** 155 pp.
3. Lalomov, A. V and Tabolitch, S. E., 1996. Catastrophism and modern geology: modelling the placer generation process. **Creation Research Society Quarterly,** 33(3): 186-190.
4. Walker, T. B., 1996. The Great Artesian Basin, Australia. CEN **Tech.** J.,10(3):379-390,Table 2.
5. Osovetsky, B. M., 1986. **Heavy Minerals of Sediments** (in Russian), Irkutsk University Publishers, Irkutsk, USSR, 250 pp.
6. Reed *et al.*, Ref. 1.
7. Graf, W. H, 1971. **Hydraulics of Sediment Transport,** McGraw-Hill, New York, 513 pp.
8. Lalomov and Tabolitch, Ref. 3.
9. Davison, G. E., 1995. The importance of unconformity-bounded sequences in Flood stratigraphy. **CEN Tech. J.,** 9(2):223-243.
10. Wells, Ref. 2.
11. Bache, J. J, 1987. **World Gold Deposits: A Geological Classification,** North Oxford Academic Publishers Ltd, London, p. 117.
12. Reed, J. K., 1996. A Biblical Christian framework for Earth history research. Part 1 — Critique of the naturalist-uniformitarian system. **Creation Research Society Quarterly,** 33(1):6-12.
13. Morris, H. M., 1996. The geologic column and the Flood of Genesis. **Creation Research Society Quarterly,** 33(l):49-57.
14. Snelling,A. A., 1991. Creationist geology: where do the 'Precambrian' strata fit? **CEN Tech. J.,** 5(2): 154-175.
15. Walker, Ref. 4.
16. Austin, S. A. and Wise, K. P., 1994. The pre-Flood/Flood boundary: as defined in Grand Canyon, Arizona and Eastern Mojave Desert, California. *In:* **Proceedings of the Third International Conference on Creationism,** R.E. Walsh (ed.), Creation Science Fellowship, Pittsburgh, Pennsylvania, pp. 37-47.
17. Wise, K. P., 1992. Some thoughts on the Precambrian fossil record. CEN Tech.J.,6(l):67-71.
18. Snelling,Ref. 14.
19. Hunter, M. J., 1996. Is the pre-Flood/Flood boundary in the Earth's mantle? **CEN Tech. J.,** 10(3):344-357.
20. Boyle, R. W, 1987. **Gold: History of Genesis of Deposits,** Van Nostrand Reinhold, New York, p. xiii.
21. Yeend, W. and Shawe, D. R., 1989. Gold in placer deposits. **U.S. Geological Survey, Bulletin 1857-G,** p. 1.
22. Ajgirey, G. D., Breshenkova, B. K., Prokofieva, A. P. and Rusinova, L. A., 1954. **Methods of Search and Prospecting of Mineral Deposits** (in Russian), Nedra Publishers, Moscow, USSR, 463 pp.
23. Yeend, Ref. 21, p. 1.
24. Boyle, Ref. 20, pp. 23,25.
25. Lalomov, A. V. and Tabolitch, S. E., 1996. Catastrophism in geology: determination of the generation time of coastal submarine placers based on mathematical modelling. CEN Tech. J., 10(3):373-378.

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