Title: Global Carbon Cycle and Petroleum Genesisis.

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Abstract

Two features of the new global carbon cycle model allow us to take a fresh look at the genesis of oil. I mean orogenic cycles and global photosynthesis. The first links the processes of the earth's crust with photosynthesis, the second ensures the synthesis of “living matter” which is a source of organic carbon in rocks. Uneven movement and collisions of lithospheric plates caused cyclic and uneven dynamics of photosynthesis. Such dynamic provided maximum accumulation of organic matter in rocks at the end of the orogenic cycles during the transition from one cycle to another. This was the time when drastic environmental events and mass extinction of organisms were taking place. As a result, rocks, rich in organic matter ("black shale"), were formed. These rocks subsequently became powerful sources for hydrocarbon generation. The presence of global photosynthesis in global carbon cycle with its ability to self-regulation, made the cycle evolving and finally led to the point of ecological compensation, i.e. to a sustainable state. The analysis of the problem by means of carbon cycle model allows concluding that the first industrial oil deposits couldn't appear before the Ediacaran (650 – 540 Ma), whereas organic-rich rocks with related oil deposits were unlikely to arise after the Miocene. This statement is confirmed by the correspondence of the distribution of known world oil reserves and the number of discovered oil fields in the territory of the former USSR as well as data on successive four stages of ^{13}C oil enrichment observed in the Phanerozoic.

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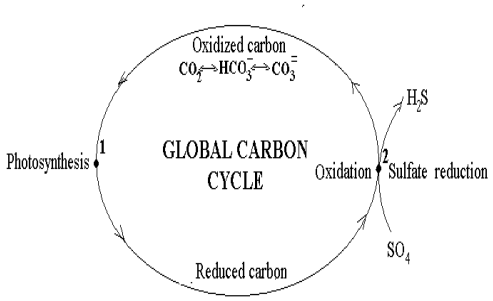


Figure I. A formal scheme of redox global carbon cycle It is closed loop consisting of reductive and oxidative branches. The oxidative branch is presented by CO_2, bicarbonate and carbonate ions, composing the common chemical exchange system close to equilibrium. The reductive branch is presented by different organic compounds, initially produced in photosynthesis. The loop has two special points. Point 1 corresponds to photosynthesis, the known redox process, where the oxidized carbon converts into the reduced carbon. The energy needed for the transition is taken from the sun. Point 2 corresponds to the reverse transition of the reduced carbon forms into oxidized ones. The oxidation of sedimentary organic carbon occurs due to the coupling with thermochemical sulfate reduction, proceeding in subduction zone where lithospheric plates collide. The needed energy supply for the reaction is taken from the heat released in lithospheric plates’ collisions.

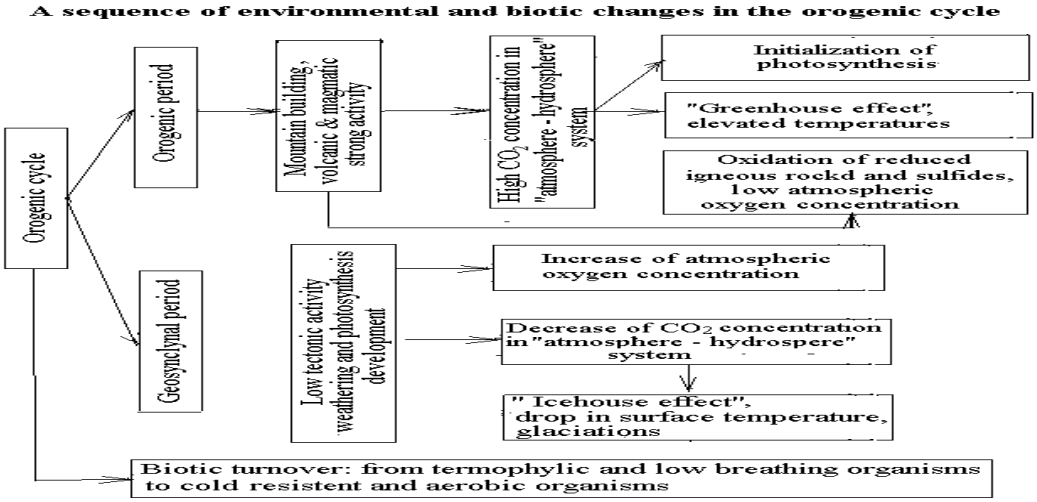


Figure II. The sequence of the environmental events in orogenic cycle concept.

1. Carbon turnover is a series successive orogenic cycles.
2. Orogenic cycle consists of short-term orogenic period and long-term geosynclynal period having different environmental conditions (see Fig. II)
3. Each orogenic cycle is a strict sequence of environmental and biotic events
4. Successive environmental change during the cycle determines biotic turnover: from anaerobic and low breathing organisms in orogenic period to cold-resistant and aerobic organisms at the end of geosynclynal period
5. The transition from one orogenic cycle to another is characterized by mass extinction caused by dramatic change of environmental conditions.

6. Burial organic matter, caused by mass extinction, provides organic carbon for “black shales” formation

Global photosynthesis is the key element of global carbon cycle**(Ivlev, 2015).**

The ability of global photosynthesis to self-regulation depending on CO_2 and O_2 concentrations in the surrounding makes the cycle spontaneously strive to a steady- state.

The equation of global photosynthesis applied to global carbon cycle looks as follows:

$$CO_2 \text{ (oxidized carbon forms)} + H_2O \text{ (ocean)} \xrightarrow{h\nu} C_{org} + O_2 \text{(atmosphere + hydrosphere)}$$

The validity of the equation is proved by means of arguments:

1. Antiphase character of the “substrate (CO_2) – product (O_2)” correlation, obtained for averaged values (Igamberdiev & Lea, 2006).
2. In-phase character of the “product (O_2) – product (burial C_{org})” obtained for averaged values (Berner & Canfield, 1989).
3. The observed successive ^{13}C enrichment of sedimentary organic matter by time averaged values during Neoproterozoic – Phanerozoic period (Hayes et al., 1999).
4. The observed successive ^{13}C enrichment of oil fractions (Andrsevich et al., 1998).
   Two last isotopic trend are the result of atmospheric oxygen concentration increase with time.
5. The first industrial oil fields are referred to Ediacaran when atmospheric oxygen concentration was 2 - 3 percent and corresponding amount of burial organic matter has been accumulated in the Earth’s crust.
6. Global carbon cycle achieves a steady-state in Miocene oxygen concentration in the atmosphere begun oscillate about average level close to present day level.

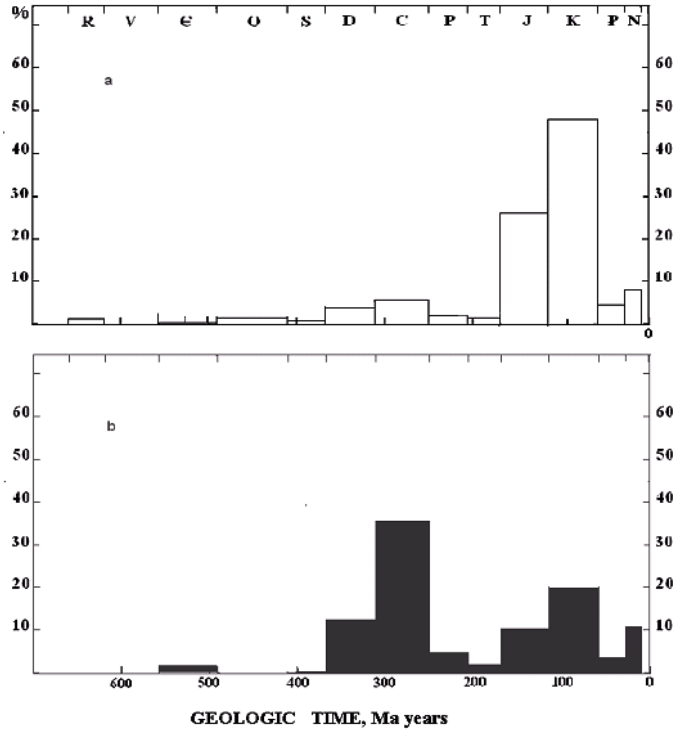


Figure III. The role of global photosynthesis in the evolution of the global carbon cycle and in the accumulation of sedimentary organic carbon.

Figure IV. Comparison of distribution of explored extractable oil fields in the largest 44 world reservoirs (Vishemirsky & Kontorovich, 1997) (a) and revealed oil fields (% of the total number of oil fields) of the former USSR (Korchagin, 2001) (b) with stratigraphic subdivisions.

The unevenness in the distribution of the extractable oil fields and a number of revealed oil fields indirectly indicate their link with the orogenic cycles.

Recent publications

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2. Berner, R.A., Canfield, D.E. (1989) A new model for atmospheric oxygen over Phanerozoic time. *Am J. Sci.,* 289, 333–61.

3. Igamberdiev A.U., Lea P.J. (2006) Land plants equilibrate O_2 and CO_2 concentrations in the atmosphere. *Photosynthesis research* 87,177–194.

4. Ivlev, A.A. 2016, Photosynthesis in Global Cycle of Biospheric Carbon // Applied Photosynthesis – New Progress / ed. Najafpour M.M. Intech Publishers. Croatia. P.53 – 74.

5. Ivlev, A.A. (2015) **G**lobal redox cycle of biospheric carbon: interaction of photosynthesis and earth crust processes. *BioSystems* 137, 1 - 11