MILANKOVITCH CYCLICITY: THE RECORD FROM MOSCOVIAN-KASIMOVIAN TRANSITION IN DONETS BASIN (UKRAINE)

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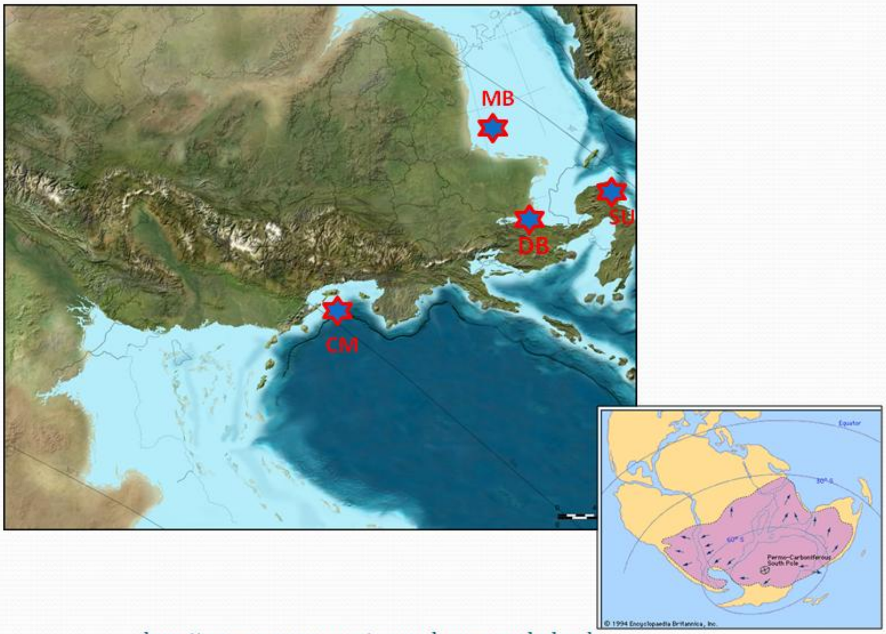
- Estimates of glacial-eustatic fluctuation are difficult to obtain from sedimentological studies because of uncertainties in determining paleobathymetry and the variable influence of tectonics and climate on erosional and depositional relief". (Feldman et al., 2005)

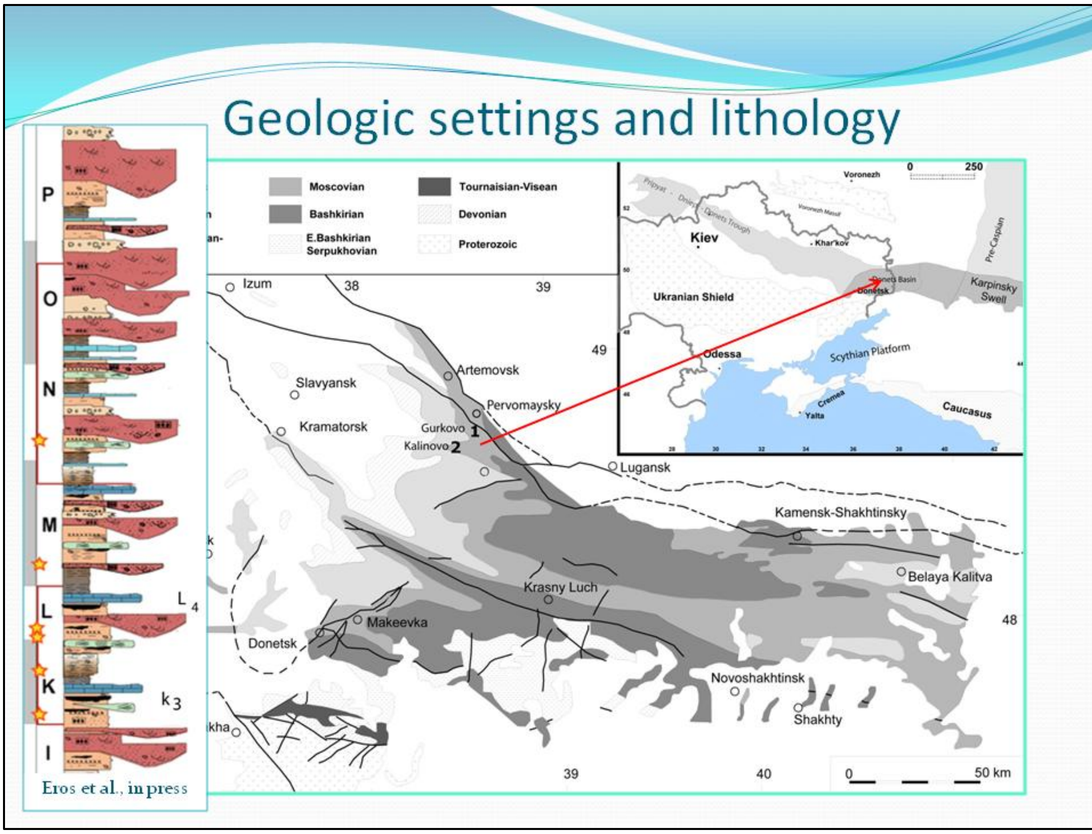
One of the main goals of my dissertation is to analyze fusulinid distribution within intermediate cycles in the Donets Basin and create a paleoecological model that will be useful for bathymetric reconstruction of eustatic sea level fluctuations in epicontinental Pennsylvanian seas.

Paleogeography

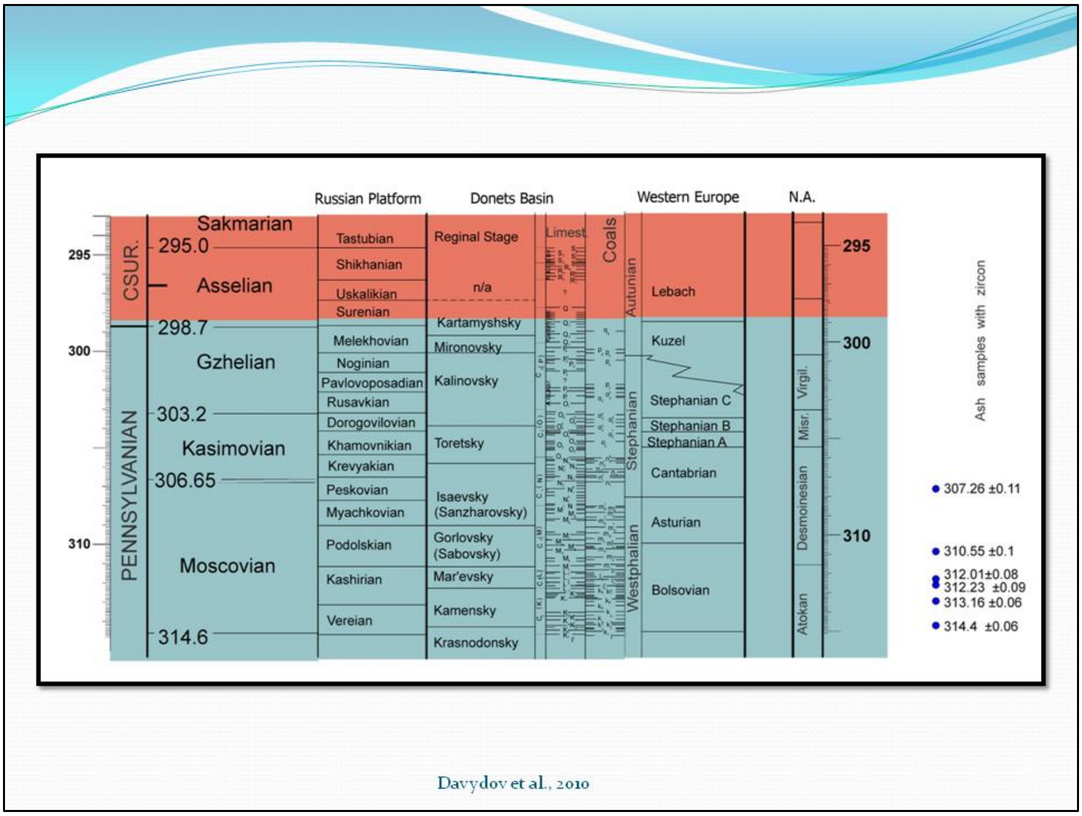


http://cpgeosystems.com/europaleogeography.html

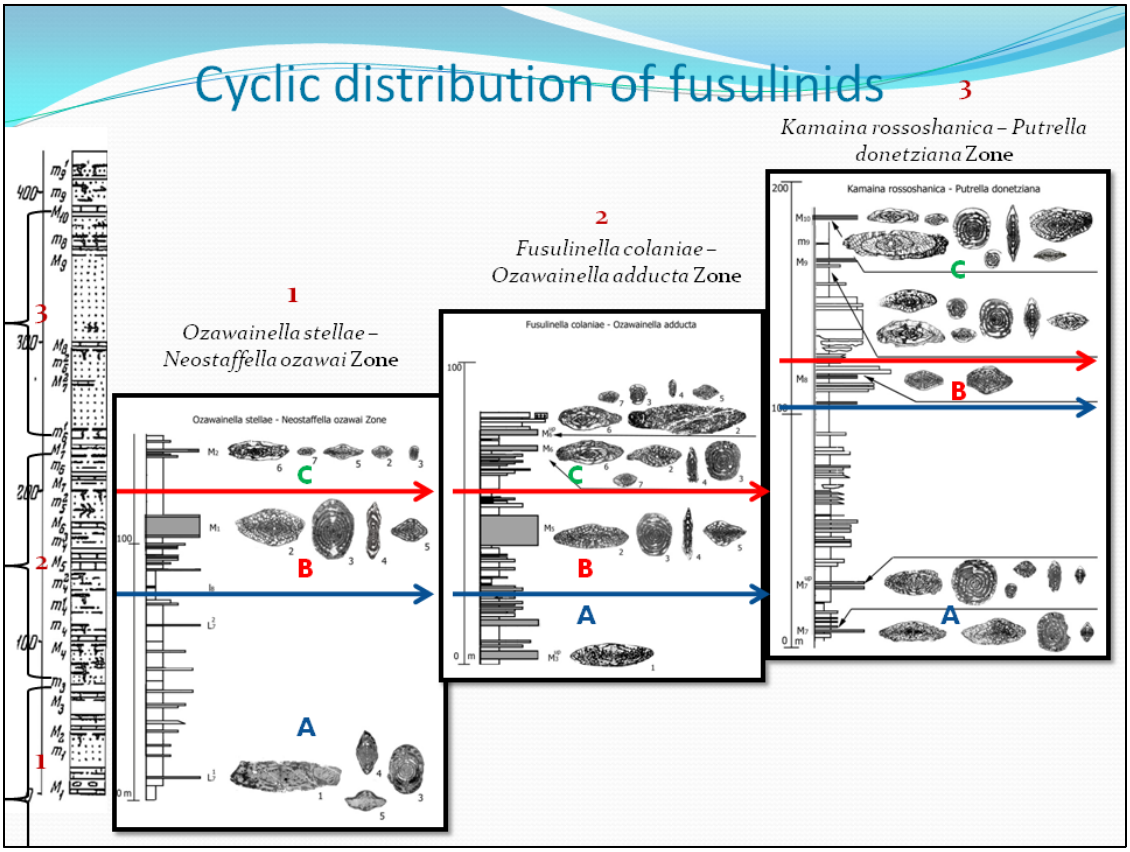
Late Paleozoic Ice Age was a dynamic time of Variscan and Hercynian orogenies, collision of Laurussia and Gondwana and assembly of supercontinent Pangea, accompanied by continental glaciations of Gondwana and dramatic climatic changes that resulted in high amplitude sea-level fluctuations, and significant biogeographic differentiation both on land and in shallow epicontinetal seas surrounded it. The Donets Basin is the southeastern segment of the Dniepr–Donets Depression, a Late Devonian rift structure located at the southern rim of the eastern European craton.



Deposition of paralic fluvio-deltaic and nearshore-marine siliciclastic deposits intercalated with limestones and coal seams occurred on a shallow ramp that steepened distally over several hundred km into the Uralian seaway and Peri-Caspian Basin. The Donets Basin contains one of the most complete global Carboniferous sedimentary successions with almost no gaps in its depositional record.



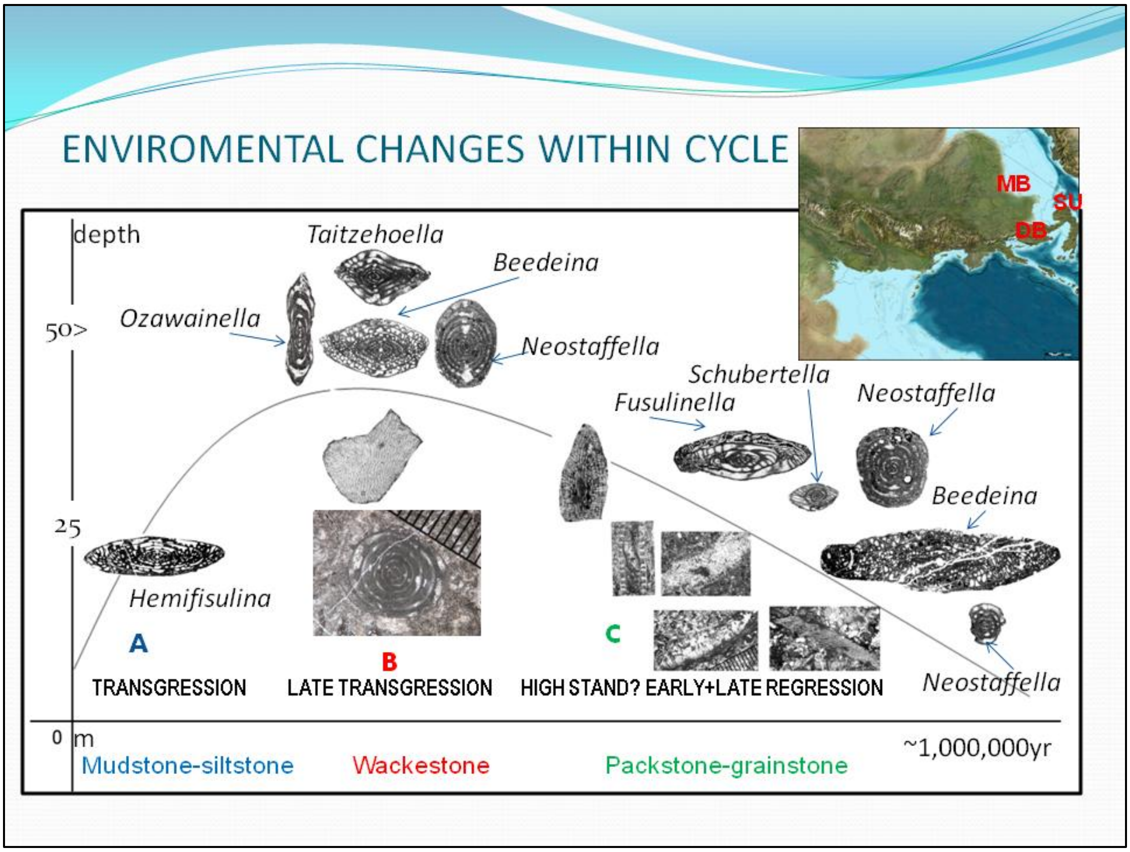
New radiometric data provided highly precise framework for the detailed lithostratigraphic, biostratigraphic, and cyclostratigraphic research. In construction of our cyclicity model we use material from four sections in the interval of the Podolskian, Myachkovian, and Kasimovian in the Donets Basin, as well as published data from the Eastern European Platform, Southern Urals, Central Asia, Cantabrian Mountains and China.



First we recognized three different generic assemblages, repeatedly occurred in Pennsylvanian succession, with evolutionary changes in species level from cycle to cycle. This evolution trends allowed definition of fusulinid biozones in the last century. In this slide we demonstrate three cycles of “M” Formation, which are correlated with Podolskian substage of the stratotype, Moscow basin. The average duration of each cycle is approximately ~1,000,000 yr.

Each cycle is started by monospecific population or low diverse community with main component of *Hemifusulina*. We hypothesize that this association was formed during the beginning of transgression. The second assemblage of scarce mature subrhomboidal in shape *Beedeina* and *Taitzehoella*, large *Neostaffella*, *Ozawainella* species characterize the offshore limestones. We bind this association with late transgression episode, or sea level high stand.

The third is represented by the most abundant and diverse population of fusulinids the main of which are *Fusulinella* and *Schubertella* species. These genera with association of other diverse fauna participated in accumulation of fusulinid packstones and grainstones during regression episodes.

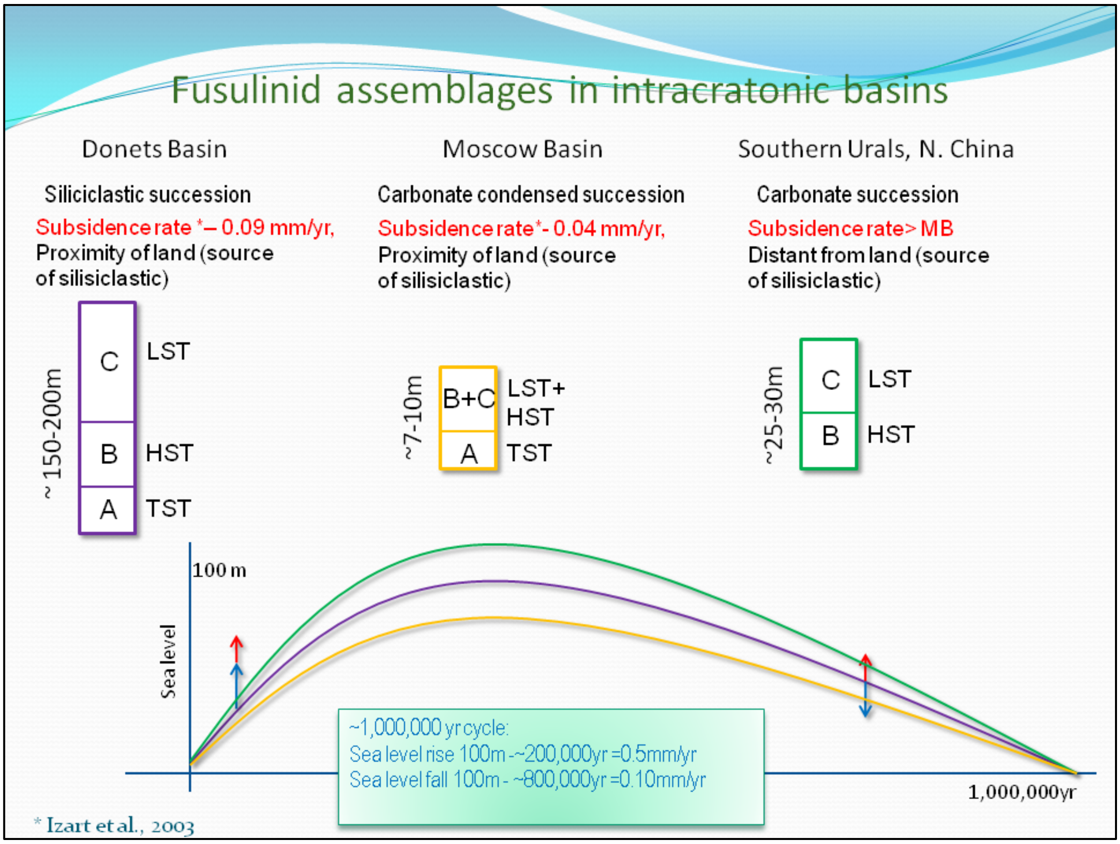


Now let me show you why A characterize early transgression, B –high stand, C – regression episodes. I tried to consider this intermediate cycle from environmental point of view, the environment that was steady enough to allow an evolution of different and distinct associations, which characterize those three events.
As glaciers at Polar Regions and in the mountains melt faster during global warming than accumulate during glacial periods, a time span of accumulation of sediments containing A and B assemblages is considerably shorter than accumulation of the limestone with C assemblage.
Hemifusulina association seems to be the only one in Moscovian time, who had preferred terrigenous either mud or silt dominated substrate. The *Hemifusulina*-bearing beds are periodically deposited since this species first appeared in Kashirian time and became extinct at the end of Moscovian. This genus differs from species of B and C associations in different wall structurethat allow me to hypothesize the deflection of salinity of sea water from normal marine because of high input of fresh water. At the same time their abundance and their association with siliciclastic rocks, as well as low diversity of other groups also evidenced of some stressful for marine community environments, mainly calcareous fauna.

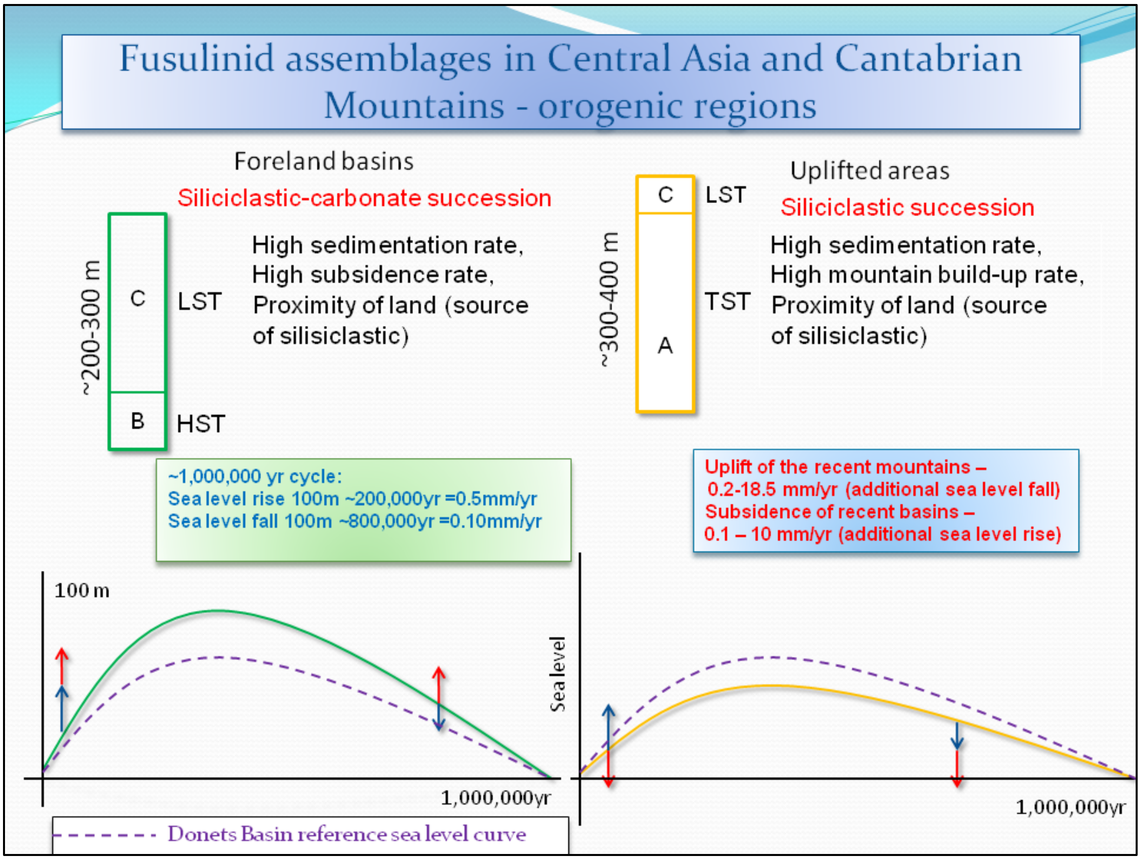
The spatial distribution of A - *Hemifusulina* is also restricted. This genus was very abundant in the Donets Basin, Moscow Basin, and its population considerably reduced in the eastern seaward direction.

We hypothesize that Hemifusulina preferentially occupied estuaries formed by flooding of eroded surfaces during sea level rise. I interpret the beginning of transgression with the intensive precipitation rate or/and decay of near-field high-mountain glaciers in the adjacent Western Europe. As the high mountains were situated at the equator, the snow first melted there, and then following late transgression probably associated with decay of far-field Gondwana's icecaps. These events were marked by deposition of off-shore normal marine wackstones with scarce and low diverse fusulinids. The micritic matrix of these limestones comprises of degraded or decomposed calcite bioclasts indicates the low sedimentation rate of such limestone. The important feature for this association is the maturity of the fusulinid specimens. The absence of immature specimens and terrigenous intraclasts indicates the quite off-shore environments. Very important is presence of red algae. Recent red algae depending on latitude, temperature, and other features can photosynthesize at depth below 35 m and deeper, at depth of penetration of blue spectrum of light. These limestones are very important for biostratigraphic correlation of distant regions, because they deposited at maximal sea level rise. All representatives of this assemblage were extinct at the Moscovian – Kasimovian transition.

Regression episode was the longest one within cycle. Slow accumulation of ice at polar region led to slow sea level fall and the very shallow depth persisted relatively longer, resulting in explosion of diverse and abundant fauna and algaflora, mainly green algae indicating shallow depth of 6 to10 m, the depth of penetration of red spectrum of sunlight. Presence of abundant immature fusulinid forms, high content of broken shells of diverse macrofauna, and smaller foraminifers are the main features for this association. This assemblage could be interpreted as early to late regression. The genera of B also occurred here but represented by different species. Beedeina and Taitzehoella species in shallowing upward succession became longer, while Neostaffella and Ozawainella became smaller.



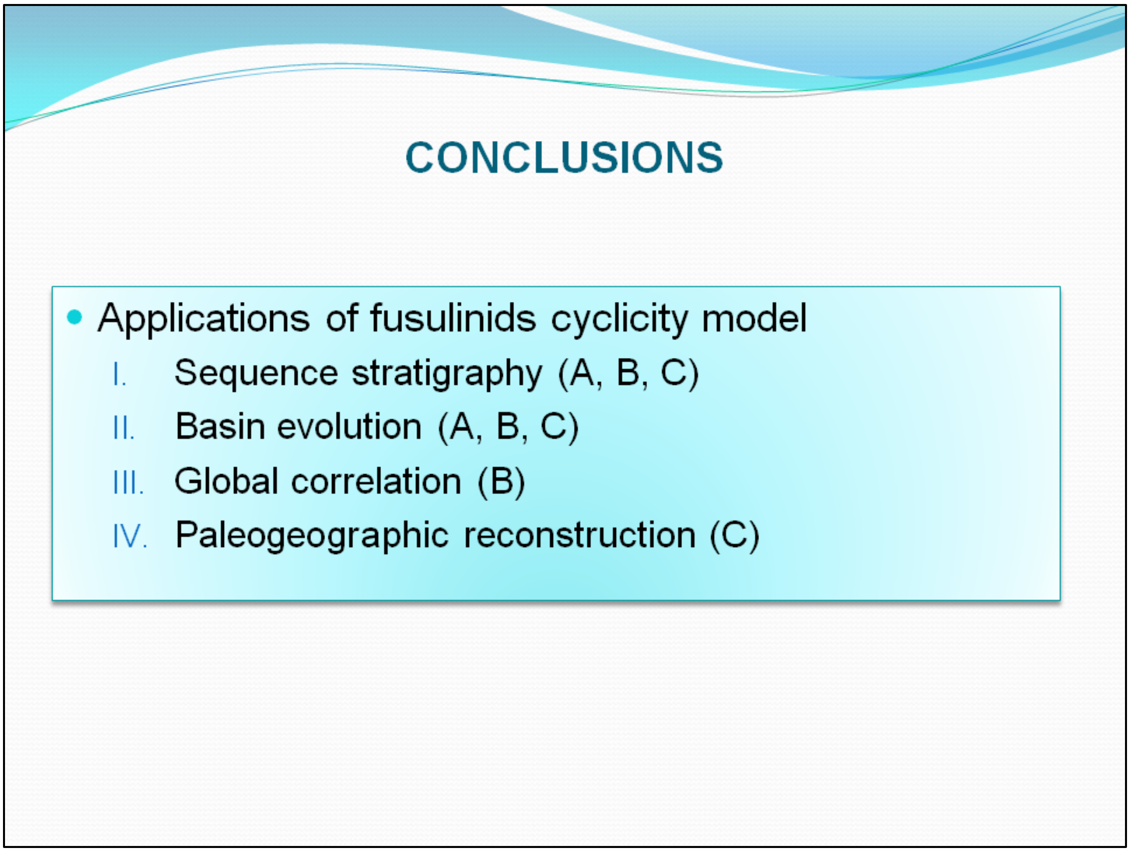
Depending on different tectonic settings we have recognized different combination of these three associations. In intracratonic basins depending on sedimentation rate and distance from land, there are three type of succession. In contract to the Donets Basin, where we recognized all three assemblages, Moscow Basin succession includes only early transgression beds. Fusulinids from late transgression are occurred together with fusulinids from regression episodes. Further to the east, in the deeper marine Uralian Foredeep, early transgressive strata disappeared, while the beds with late transgression and regression assemblages are documented separately (Ivanova, 2008).



In orogenic regions, Cantabrian Mountains and Central Asia there are two different types of successions, with different fusulinids. The first is characterized by late transgressive B and regressive C assemblage. The second coarse-grained siliciclastic succession, mainly conglomerates with sandy limestones is characterized predominately by A early transgressive association; B is absent, C – very shallow association is represented by insignificant by thickness beds with Fusulinella and Schubertella. I assume that sea level rises up to ~ 100 m during short period of transgression with rate of ~0.5 mm/yr and sea level falls up to 100 m during regression, with rate of ~0.10 mm/yr. If in intracratonic basin we can ignore basin subsidence rate, in the orogenic basins we should take into account the tectonic factor. I gave an example of data of rates in modern mountains uplift and basin subsidence. The first succession could be probably accumulated in basins with subsidence rate slightly greater than eustatic sea level fall during regression; otherwise the abundant fusulinids of C assemblages could not survive in deeper depth.

As the subsidence rate was high plus eustatic sea level rise during transgression, there is no sediments with Hemifusulina-bearing limestone. The depth became deep so quickly that was unfavorable environment for this genus.

For the second sucession with Hemifusulina-bearing limestones the uplift must not be greater that sea level rise to accumulate early transgression sandy limestones with Hemifusulina association. There is no deeper facies with B association, because the region was very shallow even during sea level rise due to its permanent uplift. The accumulation of regressive C association was reduced, because during regression sea level falls faster, because of additional sea level fall from tectonic uplift of this area.



This research has many applications. It could be useful for sequence stratigraphy in determining TST, HST, LST. It can be also applied to global correlation, using B association. This cyclicity model is also can be useful for paleogeographic reconstruction, especially C, very shallow and provincial assemblage. This model is also could be applied in basin analysis.