Modern geodynamics is an active developing science which uses all achievements of
dynamic systems theory and synergetics. It becomes clear nowadays that geodynamical
processes include wide range of spatial-temporal frequencies commensurable with climatic
and biophysical conditions. Latest researches of geodynamic processes in area of various
scale faults demonstrate wide range of their biophysical and biochemical activity. Its research
– is a task of near future. Modern data allow to believe that geodynamic state of specific
territory is not a constant but an active factor of landscape dynamics and its components,
connected with components by positive and negative feedback. The way to develop this
research is through relief structure analysis. It reflects all spatial-temporal diversity of
interactions between relief and other components. Relief is interpreted as reflection of
dynamic processes for certain moment of time. This approach bases on classic Fourier
analysis which connect the power of relief-generating process with spatial scale.

Analysis of Fourier spectrum enables to calculate fractal dimension of dynamic system
attractor, to prove existence of quasiharmonic oscillations and to determine quantity of
inducing factors (order parameters in terms of synergetic). Then we can explore spatial rules
on level of each quasiharmonics. Every harmonic produces its own set of earth surface
forms. Each harmonic has its own energy capacity. That is why we, staying within frames of
classic landscape science, can assess the role of harmonics in spatial hierarchical
organization of landscape. Thus, the proposed approach considers relief as the dynamic
basis of landscape and explores its conditions not only as the function of denudation and
accumulation but also as a function of geodynamic processes acting through geophysical
and geochemical variables.

We considered territory of East European plain. Initial data is digital elevation model
provided by US Geological Survey. Researched territory lays between 40° and 90° north and
20° and 60° east. Its initial projection – latitude/longitude, WGS-84 model. It was transformed
to Albers equal area projection with reference longitude 40 degrees east and two transverse
parallels – 45 and 65 degrees north. Spatial resolution – 1km².

Spectral analysis was realized for 2000 x 2000 km square in the center of image by
standard forward Fourier transform. Two projections to X and Y axis were taken into analysis
according to Turcotte method (1997). Spectrum power was used in logarithmic scale. Like all
similar cases, spectrum power is function of frequency or wave number. The lower the
frequency the higher power logarithm. Parameter of regression line allows to calculate fractal
dimension – in our case it is 2.2 approx. This means that regression line has rather low slope
degree and territory is characterized with rather low degree of disjunction, low diversity of
relief forms. Regression residuals prove hypothesis of quasiharmonic existence. Their
frequencies subordinate to the rule of non-linear oscillator (f = nf₀, where n is integer).
Spectral analysis of residuals reveals that there are no more than three factors determining
deviation from fractal process. Statistical reliability of quasiharmonisc allows to detach
hierarchical levels of relief organization and most probably, the landscape.

Analysis of spatial structure of different hierarchical "waves" helps us to outspreak
hypothesis of geodynamic forces direction. Each hierarchical level has been restored by
inverse Fourier transform. First four of them can be seen on fig. 1. This hierarchy creates
basis for researches of all components of landscape and their relations with relief on each
hierarchy level. The highest level (820-1024 km) among all structures we can see the
following ones with positive sign: 1. Kola peninsula, 2. Timan ridge, 3. Walday – Smolensk-

By the same way we can describe hierarchical levels - 330 to 1024 km, 118 to 330 km, 52 to 118 km, 33 to 52 km and 16 to 33 km. Individual maps show that large-scale structures coincide with uplifting and sinking zones of East European platform. Middle-scale structures coincide with local zones of tectonic movements, low-scale structures reflect erosion network partially influenced with different glaciation zones (which are also seen on maps). The result of the work is detailed information about hierarchical structure of territory, morphological units on each hierarchical level, information about tectonic movements.

The research is made with support of RFBR projects №03-05-64280, №01-05-06012.

Figure 1. Four hierarchical levels of East European plain.

References