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Grounds fertilization and improvement in anthropogenic landscapes of quarries in Russian North-West: use of natural organic substrata for intensification of soil regeneration and revegetation

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Introduction One of the main reasons of anthropogenic land degradation in the North-West of Russia is quarries and mines exploitation. This process leads to formation of vast territories with destroyed soil and vegetation cover. For 90 % of quarries the natural ways of revegetation and soil formation are typical. Only 10 % of the quarry badlands remediated, recultivated and restored by human. One of the main ways of ecosystems restoration under the human activity is artificial revegetation of mines and spoilbanks of quarries. This approach is effective, but not perfect because revegetation (the speed of succession) outstrip the changes in soil properties, especially in soil fertility. That is why, ecosystems of artificially-revegetated quarries characterizes by lower stability in comparison with naturally-revegetated areas. The main objective of this work is investigation of the effects of organic matter fertilization of grounds on the speed of soil formation and properties of soils. These problem is interesting in sense of studying of organic matter transformation in recultivated soils (Reintam et al, 2002) and in terms of soil fertility increasing under the amendment of soils by organic wastes (Ros et al, 2003). Cores The big diversity of quarry grounds can be divided on the sandy- and till-textured substrates. Particle size distribution and texture of substrata are main properties which is influence on the grounds fertility, type of soil formation and speed of revegetation. Technology of quarries exploitation includes the scraping of organic (O, T) and organic-minreal (A) horisons of natural soils and pool it in to the heaps, pits or bunkers. During several years these substrata exposed to mineralisation and humification processes. The deepness of organic matter transfor-

mation in composts is closely connected with the water and termic regimes. After 2-4 years composts were plugged into the grounds not deeper than 20 cm. In this work we investigate an effect of organic matter wastes (composts) plugging in sandy- and till-textured grounds of quarries of glacial sands and clays correspondingly. On sands 1-, 3-, and 15-years stages of soil-plant cover regeneration were investigated. Sandy grounds usually revegetate by pine seedlings. The chronoseries of ecosystems regeneration on tills are presented by 5-, 10-, 19- and 23 years soils under the coniferous (Pinus sylvestris and Picea abies) forests. Soils of each stage of regeneration were investigated by following parameters: 1. General physico-chemical analysis (pH, CEC, exchangable Ca and Mg), 2. Losses of organic matter which were initially mixtured with ground, 3. Composition of humus in horizons, fertilized by organic matter addition (Ponomareva et al., 1980), 4. Organic matter stability in soils by chemodestruction method (Popov et al., 1997). General soil properties Sandy grounds amended by organic matter input shows the tendencies in pH decreases, weathering of mineral part, increasing of cation exchange capacity (leaching of exchancheable Ca and Mg and increasing of hydrogen). Fertilization of grounds by composted organic matter leads to intensification of pedogenesis, increasing of the Aw, A and AC horizons thickness. All these tendencies are revealed in till-textured grounds, but the speed of changing are lower in comparison with sandy parent materials. In both cases the content of main nutrients (N, P, K) in soils increases. Amendment of soils by organic wastes leads to the intensification of natural overgrowing, and in cases of artificial revegetation - to activization of plant growing too. Changes in organic matter composition and content. Organic matter, which were ploughed to soils were exposed to the intensive transformation, especially during the initial 1-3 years after soil amendment. These transformation were expressed very distinctly in sandy soil. This type of revegetated grounds characterizes by low water-retention capacity, little content of clay and colloids, the great rate of the aeration porosity. All these properties are favorable to the intensive organic matter transformation, especially for mineralization. The initial content of organic matter in sandy grounds were 0,3- 1,0 %, after the fertilization by compost - 15-20 % in the layer 0-20 cm. After 3 years of wastes reaction with soil it decreases to 6 % and during the next 10-12 years it decreases to 2 %, and than became stable in time. Till textured soils shows data on organic carbon 20 % (initially ploughed), 18 % (after 3-5 years), 14-15 % (after 10 years) and became stable on the third decade (12-14 % in period 19-23 years of soil development). These data shows that the speed of organic matter mineralisation lower in till textured substrata in comparison with sandy grounds. Humus composition also depends on the texture and type of improved grounds. E.g. humus of sandy soil characterizes by prevailing of free components, which are no connected with mineral part of soil. In case of till textured grounds with high content of colloids and clay fraction humus substances, connected with calcium

and clay minerals. So, the mechanism of the great stability of humus to mineralisation deals with the humus reaction with mineral compounds of tills.

Humus stability Humus stability was investigated by original method of organic compounds chemodestruction by potassium dichromate, added to soil in mixture with different concentrations of sulfuric acid (Popov et al, 1997). This method allows to estimate the content of labile (light-oxidated), stable (which can be destructed by concentrated chemicals) and intermediate humus. In fertilized sandy ground the process of humus mineralization connected with the loses of labile humus fractions. 50-60 % of humus in 3-years soils are presented by labile humus. After 10-12 years portion of labile humus decreases to 20 % of total organic carbon content. The mineralization loses of humus in till-grounds also connected by light-oxidation fractions. Its content decreases from 70 % to 30-40 % to total carbon. Usually initial composts are not very humified, transformed, oxidized. After transformation in soils its became reached by oxygen and nitrogen, in opposite to scrapped litter and turfs of natural soils. Conclusions The general trend of wastes organic matter transformation in soil is mineralization (on the first stages) and further humification. During the transformation of wastes in soils unstable fractions loses. The remains of organic matter presented by humified and stable humus acids. Fertilization of grounds by organic matter leads to intensification of revegetation, soil formation, changing of main morphological and chemical properties. Sandy-textured grounds exposed to the organic matter affect more than tills, which are more buffered (stable) for amendment. These differences are expressed in all soil features. References Ponomareva V.V., Plotnikova T.A. Humus and Soil Formation. Leningrad, Nauka, 1980. Popov A.I., Chertov O.G. et al. Using of chemodetruction fractionation for estimation of qualitative of soil organic matter // Abstracts of 18 International Meeting on Organic Geochemistry. Maastricht, Netherlands, 1997, p. 915-916. Reintam L., Kaar E. et al. Development of soil organic matter under pine on quarry detritus of open-cast oil-shale mining // Forest Ecology and Management, 171 (2002), p. 191 - 198. Ros M., Hernandes M.T., Garcia C. Soil microbial activity after restoration of a semiarid soil by organic amendments // Soil Biology and Biochemistry, Vol. 35, Issue 3, pp. 462-469. Acknowledgements The great acknowledgements are made to the FP 6 Programm, project 013388 “OMRISK”