

---

## Introduction

---

Environmental impact caused by mining is considerable. The impact of mining on relief and landscape character is particularly substantial as could be documented on earth material transfer. While transfer of earth material caused by natural processes (erosion, sedimentation) is about 4 millions of cubic meters per year, anthropogenic transfer is close to 330 millions (Kukal, 2006) and material transfer due to mining represents the greatest proportion. It is estimated that the surface mineral extraction already covers 1% of the land surface (Walker & del Moral 2003). In the Czech Republic the extent of mining sites reached 0,8% in 2006 (Statistical Environmental Yearbook of the Czech Republic 2008).

Mining causes irreversible modification of relief, removes vegetation and soil cover causing loss of biotopes. On the other hand mining creates new sites in the landscape e.g. water bodies, rock walls and screes. These sites are often unique and contrasting with the surrounding landscape and might harbor specific species after mine/quarry abandonment. Traditional approach to restoration was considered to be the restoration (reclamation) of production, whether agricultural or forestry, causing elimination of potential site diversity by morphology adjustment, topsoil application and tree planting or trefoil-grass mixture sowing. Stone quarries were often filled with wastes, covered with topsoil and planted. This technical approach, mechanically applied to any site not considering potential values of created sites, has unfortunately remained till present in most reclamation plans (Sádlo & Tichý 2002). It has also been argued that this practice is very expensive.

Number of studies of spontaneously revitalized mining sites (quarries, mines, dumps) have proved that majority of such sites have the potential to be restored spontaneously by spontaneous succession or directed succession. Furthermore the result of spontaneous

restoration has been a varied mosaic of communities reflecting site conditions and not a plantation of trees or species poor artificial grassland.

It has also been argued that spontaneously restored sites often harbor species vanishing from landscape due to habitat loss, fertilization and land use changes (see Tropek & Konvička 2008, van Swaay 2002). Many of mining sites have become under natural processes important sites for endangered species. Other sites have been important from the viewpoint of geology, mineralogy, paleontology or have become important structural landscape elements (components of the TSES – Territorial system of ecological stability).

There are many studies highlighting natural values of mining sites as well as demonstrating the potential of spontaneous restoration, in the Czech Republic (e.g. Sádlo 1983, Sádlo & Tichý 2002, Novák & Prach 2003, Řehouňková & Prach 2007, Prach et al. 2001, Cílek 1999, Tichý 2006). The Central registry of natural reserves of the Czech Republic provides further evidence of their potential values. Quarries, mines or dumps have been designated as natural reserves after spontaneous succession have led to species rich communities of plants or these sites have been colonized by endangered plant or animal (e.g. amphibians, bats or invertebrates) species.

However the spontaneous restoration is not to be meant to entirely replace technical reclamation. In some places the technical reclamation is the only possibility but the problem is its mechanical application elsewhere.

With respect to results of above mentioned studies, spontaneous or directed vegetation succession certainly is the alternative way to technical reclamation (Cílek 1999, Sádlo & Tichý 2002, Prach 2006, Tichý 2006; Bradshaw 2000, Yung 2000 and others). However the spontaneous restoration should follow several principles. As this study is focused on stone quarries, several principles only for these anthropogenic landforms are mentioned: quarry walls and quarry levels (etages) should be morphologically modified to resemble natural rocky slopes, rock walls and outcrops; quarry walls should be stabilized to protect mass wasting; vast quarry floor might be divided by several elevations but dumping of allochthonous material or using such materials for morphology adjustment should be excluded. Moreover, the goal of morphological adjustment is the preservation of unique geological profiles and maintaining or even increasing site's diversity. Spontaneous or directed succession is initiated in the abandoned morphologically adjusted quarry. The desired quarry morphology can be shaped during quarry operation which is the obvious advantage, and not necessarily after termination of quarrying.

New approach to mined land restoration requires knowledge of factors controlling spontaneous vegetation succession. This has resulted in number of scientific studies of such factors. The role of environmental factors and landscape factors has been generally accepted.

The need for degraded land restoration as well as ecosystem restoration, species and biodiversity protection has led to establishment of new scientific discipline the restoration ecology in the 80's of the last century. Restoration ecology as a science gives the theoretical background for the practical restoration (Prach 2006).

Mining and quarrying will certainly continue in a current society in future, therefore we should focus our attention on acquiring the knowledge of factors controlling restoration likewise utilizing potential of dumps and quarries for biodiversity protection.

Studies of spontaneous quarry restoration, which have been published in the Czech Republic so far, were focused on quarries of rocks of specific chemical composition (e.g. limestone and basalt) harboring high species diversity (Tichý 2006). Furthermore studied quarries were located in landscapes with specific climatic conditions as well as regional species pool in context of the Czech Republic. Only little attention has been paid to granodiorite quarries and dumps in neutral landscape so far. The so called neutral landscape means, in context of the Czech Republic, the landscape of average environmental gradients e.g. neutral to acidic bedrock, average temperature, average precipitation and species pool common for the mesophyticum region of Czech flora.

The main aim of this research was to present a comprehensive study of spontaneous restoration of granodiorite quarries and dumps. The research was focused on identification of main factors influencing spontaneous restoration including soil development and biodiversity of dumps and quarries. The study was carried out near the town Skuteč in the Czech Republic where there are many quarries and dump sites in a relatively small area. The concentration of these sites was a great advantage as spontaneous restoration and soil development as well as biodiversity were not affected by diverse chemical composition of bedrock, climatic gradient or variable regional species pool.