# Soil Impact Assessment Study As A Result Of Mining And Processing Operations Of The Roşia Montană Gold Ore

Prepared for:

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# 1 Introduction

S.C. Roşia Montană Gold Corporation S.A. ("RMGC") is proposing to upgrade and develop the Roşia Montană gold and silver mine. An exploitation license was issued for this purpose granting the concession of the development-mining right of the gold-silver and base metal resources and reserves within the Roşia Montană deposit over an area of 4282 ha.

It is intended to undertake mining operations on surface by open pit mining; four open pits, the Cetate, Cîrnic, Orlea and Jig-Vaidoaia pits, will be mined.

A processing plant, tailings management facility, waste rock dumps, pads for low grade ore or soil stockpiling will be constructed for the treatment of the excavated ore.

In addition to the above a road network will be developed.

The entire operation starting from ore extraction to the production of gold-silver concentrates, doré ingots, respectively and particularly the development of industrial structures will impact on the environment.

In order to define the nature and intensity of soil impacts, S.C. Roşia Montană Gold Corporation S.A. has contracted an Assessment Study with the Research Institute for Pedology and Agrochemistry. The formal document has been registered under No. 2713 of 23.07.2003 with the Supplier and under No. 137 of 13.08.2003 with the Beneficiary.

# 2 Investigated Site

The investigated site is bordered at north by the Roşia and Vîrtop valley interfluve, at east by the interfluve separating the Vîrtop, Roşia and Corna creeks from the watershed of the creeks flowing to the north-east towards the Ariesului Valley or eastwards, at south by the Corna and Abruzel valley interfluve and at west the area is bordered by an imaginary NS line joining the northern part of the Iacobesti village, passing at south the Sălişte Hill, Sălişte Valley and Baiesilor Hill, with the Corna valley.
The total area of the investigated site is 1,785 ha.

## 2.1 Natural Environment

**Topography**
The site's topography is determined by the variety of geological formations. Volcanic sequences are predominant impressing with the following Massifs: Carnic, Cetate, Orlea, Curmatura with elevations ranging between 1000m and 1300m.
Altitude below 1000m covers most of the area, the lowest elevation ranges between 550m and 580m in the Roşia Montană Valley.
Sedimentary sequences generated a hilly setting with shallow and occasionally steep slopes, particularly in the vicinity of streams and creeks. The watershed has created a relief consisting of small hills and ridges grooved by deep valleys.
**Geology - Lithology**
The Roşia Montană gold and silver deposits are of epithermal and mesothermal type associated with Neogene volcanic and sub-volcanic andesite-dacite bodies intruded in a large lithological variety. At Roşia Montană the dacite sub-volcanic bodies intruded primarily into Cretaceous black shales.
*The Cretaceous sedimentary deposits* cover a large area of the investigated site. *Dacite intrusions* are characterized by the presence of quartz and plagioclase feldspar phenocrystals with a coarse grained porfiry texture.
*Dacite intrusions* are characterized by the presence of quartz and plagioclase feldspar phenocrystals with a coarse grained porfiry texture. Dacite is fractured and brecciated with sediments of various minerals including sulphides in the fissures and breccia matrix.
A *magmatic-phreatic breccia* was delineated around the dacite domes with intercalations of grit stone, conglomerates, porfiry, micaceous schists and a large variety of micro-crystals. Breccia is of pyroclastic type formed when the vapours and gases segregated from the flowing ground waters. The rock is also called "microconglomerate" or “vent breccia".
The *black* or *phreatic-magmatic breccia* has a dark-brown to black colour and a matrix of black and sandy clay. It consists of quartz crystals, altered feldspar crystals, muscovite and biotite lamelles and disseminated pyrite. This type of rock occurred when the ascending magma reached the groundwater table.
A *magmatic -phreatic breccia* also called mixed breccia occurs as well, similar to the black breccia, but lacking the black colour and high content of clay minerals.
Inside, the dacite bodies are brecciated distinctively ranging from *fissuration breccia* to *matrix breccia*. These breccias are intensely silica-altered over centimeter fragments.
*Andesite rocks* cover both Cretaceous sediments and Miocene "vent breccia" surrounding the Carnic-Cetate dacite. Andesite with hornblende and grey feldspar phenocrystals with a faintly oriented structure occurs on hill ridges north of Roşia Montană. A pink-brown andesite with feldspar phenocrystals and some hornblende and without an oriented structure partly overlays the gray andesite.
*Structurally*, the cretaceous sedimentary deposits were folded around axis oriented primarily EW and faulted. The main faulting orientations are NW-SE, NE-SW and N-S. Younger Miocene intrusions, the Roşia Montană breccia rocks as well as the Roşia Poieni andesites were broken off by the same faults. Conversely, the magmatic- phreatic breccia

and vent breccia were not folded, however they reveal a large range of dipping and elongation trends due to displacement and rotation as a result of faulting.
*Gold and silver mineralization* is associated with dacite and mixed breccia bodies, occasionally it is hosted within the mixed breccia and associated with disseminated sulphides and native gold and silver. Mineralisation outlined within the vent breccia is in the form of stockwork, mineralised veins and alteration bands.

**Climate**

The regional climate is continental temperate. The multi-annual average temperature is 6$^{o}$C with seasonal variations. Average temperature in winter is -5,5$^{o}$C, ranging between 16 and 17$^{o}$C in summer. First frost occurs around the 1$^{st}$ of October and defrost around May, 1$^{st}$. The snow layer measures 35-40 cm and over 1.5m in snowbound areas.
Multi-annual average precipitation is about 1200mm. The highest precipitation values occur in spring and occasionally in summer.
The dominant winds are of western circulation with added intense foehnal circulation contributing to the snowmelt and raise of river water levels.

## 2.2 Hydrology – Hydrogeology

**Surface Waters**

**Watercourses** with permanent character in the area are Roşia and Corna streams. The Roşia stream originates from Tăul Tarina, Tăul Mare and Tăul Brazi and flows through the localities of Roşia Montană, Balmoşeşti, Ignatesti, Iacobesti into the Abrud River at Gura Rosiei. The stream collects the ARD water changing its colour into yellowish-reddish due to the iron oxides occurring within the traversed volcanic rocks. The stream maximum flow rate is 300l/min.
The Corna stream originates from Tăul Corna, runs along the localities with the same names and slows into the Abrud River on the territory of the town of Abrud.
The Sălişte stream flows between the Roşia and Corna streams and is also a tributary of the Abrud River. A tailings deposition pond is constructed on the Sălişte valley.
In addition to these permanent watercourses, a number of semi-permanent watercourses are encountered occurring during periods of heavy rainfalls and snowmelt. They are of flood type with maximum flows in spring.
**Lakes** in the Roşia and Corna watersheds were built for the operation of stamps for the treatment of gold ore. Today there are five significant lakes as follows Tăul Mare, Tarina, Brazi, Anghel and Corna. They are located at elevations between 950 m (Tarina) and 1000 m (Tăul Mare). The largest lake is Tăul Mare which covers an area of 32,120 $m^2$ and contains a water volume of 160600 $m^3$, while the smallest is the Brazi Lake with an area of 7,800 $m^2$ and a volume of 22 000 $m^3$. Maximum depth ranges between 10m (Tăul Mare Lake) and 3.6m (Corna Lake).

**Groundwater**
Due to the geological structure consisting of low fissuration rocks, the Roşia Montană region is not rich in groundwater courses. Active springs occur at the contact between sedimentary rocks and massive compact rocks, but they dry out in summer.
Groundwater also occurs as confined ground-water sheets in delluvial deposits as a result of accumulation of rainfall waters.
**Vegetation**
The predominant vegetation within the investigated area consists of a complex of grassland, fruit gardens, locally also sporadic vegetable crops.
Meadows consist of a large variety of species such as: *Trifolium arvense, Spergula arvensis, Setaria virids, Gypsophila muralis, Gnaphallium uliginosum, Centaurea phrygia, C. scabiosa, Cynosurus cristatus, Plantago lanceolata, P. media, Poa pratensis, Poligonum aviculare, Silene sp., Calamagrostis epigegas, Calluna vulgaris, Poa pratensis, Festuca pratensis, F. rubra, Agrostis stolonifera, A. Tenuis, A. capillaries, Alopecurus pratensis, Sieglingia decumbens, Glyceria maxima,* and locally *Juncus gerardi, Puccinelia distans, Deschampsia caepitosa.* Varieties such as: *Malus, Prunus, Pirus, Rubus,* etc. occur in fruit gardens.
Forest vegetation primarily consists of *Fagus* and *Carpinus* species. *Fagus silvatica* is predominant. *Abies* and *Pinus* are predominant at higher altitudes, while along watecourses varieties of *Betula, Populus* and *Salix* also occur. *Betula pendula, Pinus sylvestris, Populus tremula*, *Vaccinum myrtillus* and *Vaccinum vitisidea* occur within historical mine sites.
**Soil Overburden - General**
Given the environmental conditions, the overburden soil is relatively diverse in terms of type and sub-type and particularly at lower levels where a number of soil characteristics (thickness, parent material, grading of deposits, texture class and skeleton content) are associated with site characteristics (relief, slope gradient and subjacent rock).
The soil map drawn up by us shows that 8 units of soil types and subtypes and 19 units of associations of soil types and soil subtypes were delineated witihn the investigated site (see the map legend).
Soil types and sub-types are represented by: typical or lithical bruni eu-mesobasic soils; typical, andi or lithical acid bruni soils; typical regosols and typical colluvisols and typical lithosols.
Soils in the region were rated as per the principles and criteria of the Romanian Soil Rating System (1980) and further correlated with the W.R.B.-S.B. (1998).

## 2.3 Natural Risk Areas

Due to the site geological conditions, morphology, impact of exogenous factors and primarily due to the anthropic impacts there is a high potential for occurrence of natural events such as landslides, rock falls etc. in the area.
Rock alteration and erosion, particularly of sedimentary rocks led to the deposition of eroded materials on shallow slopes forming delluvial deposits resulting in materials subject to land slides. A landslide event occurs is the result of external factors and formation of a montmorillonitic clay bed able to maintain the slide. The presence of lakes may accelerate the landslide event and generate suffosion events.
Landslides can be easily noticed on the upper course of Roşia and Corna streams.
No forms of accelerated soil erosion have been encountered in the area, with the exception of erosion of narrow valley type occurring on narrow valleys tributary to larger valleys. However, geological erosion occurs over areas with regosols in association with other soils.
Rock falls and detritus nappes can be noticed within the area of the county roads connecting the localities of Gura Rosiei and Corna and may also occur within the area of rock waste dumps, dumps split up by flood flows and developing valleys. During extreme rainfall events the coarse and fine material is carried down to the bottom of slopes, thus

expanding the damaged area.  This type of events can be easily notices at the Cetatea, Carnic, Orlea and Oarta Hills.

# 3 Data and Methods

Soil surveys were conducted during the *field investigation phase* over an area of 1785 ha, a total of 40 soil profiles were completed of which 24 on the plots purchased by S.C. Roşia Montană Gold Corporation S.A. and 16 on pre-contracted plots.
A total of 157 samples in disturbed structure and 317 in undisturbed structure were collected from these profiles. In addition, a total of 41 samples were collected from the fertile horizon for the purpose of microbiological analysis.
Profile sites were located by GPS and each profile was photographed.
A total of 103 agrichemical average samples were collected for agrichemical mapping purposes at depths varying between 0-15 cm or 0-20 cm, depending on the fertile horizon thickness. Each agrichemical average sample was composed of 45-50 partial samples. The 130 agrichemical average samples were collected over a total area of 1785 ha.
A large suite of physical, chemical and microbiological assays was conducted *in the laboratory*.
Physical assays comprised 6 parameters (particle size analysis with 10 fractions, moisture-content, density, total porosity, penetration resistance, hydraulic conductivity), totaling 1902 assays. Determination of shrinkage index was also conducted.
Chemical assays comprised 21 parameters ($pH_{H_2O}$, $pH_{NaF}$, $CaCO_3$, SB, SH, T, V, organic matter content, total nitrogen, heavy metals - Fe, Mn, Cd, Cu, Cr, Co, Pb, Zn - content in mobile forms of phosphorus, potassium and aluminum). A total of 1521 chemical assays were conducted.
Microbiological assays consisted of qualitative and quantitative determinations of bacteria, fungi and soil breathing; 123 assays were completed.
Agrichemical average samples were assayed for pH, SB, AH, organic matter content, mobile phosphorus and potassium content and total content of heavy metals: Cd, Co, Cu, Mn, Ni, Pb and Zn. A total of 1339 analytical assays were completed. The nitrogen supply level was determined based on the nitrogen index.
All physical, chemical and biological assays were conducted using standards procedures.
A database was compiled during office work comprising all soil profiles physically, chemically and microbiologically assayed and analytical results of agrichemical mapping.
Maps and charts at 1:10000 scale were prepared as follows: soil map, soil texture map, favorability map and fertile horizon thickness chart, texture chart, humus reserve chart, soil reaction chart, organic matter content chart, nitrogen, mobile phosphorus and mobile potassium supply charts.

# 4 Results and Comments

## 4.1 Pedologic Description of Soil Overburden

Due to the site conditions (relief, surface lithology, hydrology-hydrogeology, climate, vegetation) a diverse soil overburden developed in the area. The soil diversity is more significant at sub-type level and particularly at a lower level being conferred by the association of soil and land characteristics within the respective sites, conditioning their dissemination rules.
In order to emphasize the above mentioned the decision was to use the soil-site formula comprising the main characteristics of the soil and site (see the Soil Legend on the map). Soils in the region were rated as per the principles and criteria of the Romanian Soil Rating System (1980) and further correlated with the W.R.B.-S.B. (1998). Field data and laboratory analytical results were interpreted and organized according to the provisions of the "Soil Study Preparation Methodology" (I.C.P.A., 1987). The quantitative signification of the soil properties is given in the Soil Legend.

## 4.2 Soil Types and Sub-types

Following the soil mapping and using the above-mentioned criteria soils belonging to the cambisoil class and non-evolved, truncated or loose class.

**Cambisol Class**
The following soil types and sub-types of this class were encountered:

- Bruni eu-mesobasic with typical and lithic sub-types (BMti, BMls);
- Acid bruni soils with typical, andi, lithic, andi-lithic sub-types (BOti, BOan, BOls, BOan-ls).

**Non-evolved, Truncated or Loose Soil Class**

- Typical regosols (RSti);
- Typical colluvisols (COti);
- Typical lithosols (LSti).

Due to the parent material and site (slope) characteristics the followings also occur in association with the sites: cambi andisols (umbrisol class) and typical lithosols (non-evolved soil class).

### *4.2.1 Typical Bruni Eu-mesobasic Soils - BMti - (Eutric Cambisols)*

**General Description**
These soils are characteristic to low altitude (600-800 m), low-moderate rough sites with short or long, even or uneven slopes, moderately steep (slope gradients of 12-25%). The parent material derives from argillaceous sediments with argillaceous marls and argillaceous-sandy flysch with calcareous cement.
Soil profile is well developed; soil thickness varies from 51 - 75 cm (semi-deep soil) to over 1m (very deep soil). This tpe of soils occur in the Corna Valley basin, interfluve between the Corna and Roşia valleys, on the parent material deriving from the argillaceous flysch with sandy and calcareous sequences of Abian-Aptian sedimentary formations.
Soil profile is of Ao-AB-Bv-Cn(Cn/R) type; compact or fragmented rock may occur in the Cn horizon.

Genetic horizons have varying thickness and a weak-moderate structure (grainy-polyhedral sub-angular, low-moderate). An At layer occurs at the upper part of the Ao horizon, formed of a paste of fine-very fine roots. Presence of skeleton (contained in the host delluvium) can also be noticed along the profile; the soils range from weak skeleton-wise (6-25%) at the upper horizons to strong skeleton-wise (51-75%) at depth [ Bv-Cn(Cn/R) ]. This generally results in average edaphic volume values.

**Physical Properties**

Soil texture varies from silty sandy clay to silty clay (13.5-31.3% clay $<$ 0.002 mm), this texture maintains along the profile (18.2-30.3 clay $<$ 0.002 mm). Presence of skeleton (see analytical data and soil texture map) should be noticed. As a result, the apparent density (AD) has extremely low values (0.76-1.33 g/cm$^3$) in the Ao horizon and very low-moderate (0.83-1.46 g/cm$^3$) along the profile. Correspondingly, the total porosity (TP) is high - extremely high (50-62%) in Ao and moderate - very high (45-55%) along the profile. In these conditions, soils are poorly consolidated to moderately loose, the soil settlement factor (ST) has values between +9 to 20 along the soil profile.

Hydraulic conductivity (K) has average-very high values (6-11 mm/h) in Ao and 4-70 mm/h along the profile.

We specify, that in our opinion, the skeleton occurrence affects the values of some of the physical properties (AD, TP, K), as these properties are determined on samples in natural setting, collected in 100 cm$^3$ containers. In this case, occurrence of a certain skeleton percentage in the collected sample can not be avoided.

**Chemical Properties**

Bruni eu-mesobasic soils are poor-well supplied with organic matter, the Ao horizon has an organic matter content varying from low-average (1.6-8.3%) to low (1.9-2.7%) down to 50cm depth. Therefore, the soils have a low to average organic matter (humus) reserve (125/220 t/ha) over the 0-50 cm depth (see the organic matter reserve map).

Soil reaction varies from moderate acidic to low acidic (pH 5.1-6.8) in the Ao horizon, turning into moderate acidic-neutral (pH 5.2-7.0) along the profile depending on the parent material properties.

Total nitrogen supply (Nt) is poor-adequate in the Ao horizon with a content of 0.112-0.434% (low-high), ranging to 0.048-0.275% (very low-high) in the subjacent horizon.

The C/N ratio ranges between 7.1-12.2 in the Ao horizon and 10.4-27.4 along the profile, characteristic to the acidic mull and mull calcic type.

In general, soils have a very low supply of mobile phosphorus ($P_{AL}$), many samples revealed only traces of this element, while other samples (few) showed grades of 93 ppm (very high) in Ao and 19 ppm in the subjacent horizon.

Mobile potassium ($K_{AL}$) content varies from very low to very high (121-660 ppm) in the Ao horizon and very low-very high (46-553) below this horizon.

Cation exchange capacity T (SB+SH) mg/100 g soil is low-moderate 13.2-272 in Ao and 12.2-27.1 along the profile, turning into very low (8.8) in the deeper horizons. Therefore, the soils are moderately well saturated in alkaline cations; the percentage of saturation ranges from 55% to 92% in Ao and from 68% to 83% along the profile, falling into the meso-eumesobasic saturation range.

High-average amounts of variable Al were encountered in some profiles (0.6-1.4 me/100 g soil in Ao and 1.6-2.2 me/100 g soil, on profile).

### *4.2.2 Lithic Bruni Eu-mesobasic Soils - BMls - (Lepti-eutric Cambisols)*

These soils differ from the typical soils by occurrence of a lithic contact (R-hard rock) between 20-50 cm. In this case, the soil profile type is Ao-Bv-R; the soil is moderate-superficial. All other morphologic, physical and chemical properties vary within the typical sub-type limits (see the Database).

Similar to the previous soils, these soils occur both as monotypic units and in association with other soil sub-types as first or second element. In the field they occur on moderately steep - steep slopes. The soils are moderate to strong skeleton-like (26-75%).

### *4.2.3 Andi Bruni Eu-mesobasic Soils - BMan - (Andi-eutric Cambisols) and Andi-Lithic Bruni Eu-mesobasic - BMan-ls (Andi-lepti-eutric Cambisols)*

The occurrence of these soils is strictly related to areas with sedimentary volcanic formations, where andesite prevalence results in the andi character of the soil.
It is noted that the andic character of these soils is stronger if the soil is thinner; or in a better-developed profile if the deeper horizons are located more closer to the andesitic parent material. Specifically, the more stronger the link with the andesitic deposit the more apparent the andic character.
Soil profile is of type Ao-Bv-Cn or R. In the Ao horizon, soil texture varies from moderate sandy clay - coarse sandy clay (12.7-17.1% clay $<$ 0.002 mm) to average argillaceous clay (33.2%) in Ao and maintains along the profile (18.3-33.7%). Other physical properties have values determined by the clay content $<$ 0.002 mm.
Organic matter content (humus) varies from moderate to high (5.7-8.6%) in the Ao horizon turning into moderate below this horizon (2.8-4.0%) which provides a moderate reserve along a depth of 0-50cm (218-235 t/ha).
Soil reaction is moderate acidic - low alkaline in Ao ( $pH_{H_2O}$ 5.3-7.4) and moderate acidic - neutral along the profile ( $pH_{H_2O}$ 5.1-7.1). Soil reaction in NaF (sodium fluoride) shows a $pH_{NaF}$ of 95-9.6 (very strong alkaline) in Ao and the same reaction along the profile ($pH_{NaF}$ 9.8-9.9), as a result of amorphous materials occurrence in the adsorptive complex. Other chemical properties are described in the Database.
These soils have been encountered in association with other soils. Typical lithosols occur as the second element when the soil thickness varies from superficial to moderately deep ($d_1$-$d_4$).
The soils are primarily used as secondary meadows (grass and grazing lands); the forests covering only a small area.

### *4.2.4 Typical Acid Bruni Soils - BOti - (Dystric Cambisols; Eutric Cambisoils) and Lithic Acid Bruni Soils - BOls - (Lepti-dystric Cambisols)*

**General Description**

These soils occur in any type of topographical environment (slopes, ridges, hills) with shallow to moderately - very steep slopes (2-25%).
Parent material consists of elluvial-delluvial deposits with medium texture deriving from the Maastrichtian gritty flysch sedimentary deposit.
These soils are widely spread in the region, generally occurring at high altitudes (700 - 800m) in the Corna Valley basin and north of the Corna Valley basin. They occur in mono-typical units and also in association with BMti, LSti or BMls.
Soil profile is of Ao-AB-Bv-Cn(Cn/R) type. The soils are semi-deep - moderately deep (51-100 cm), occasionally weak-moderate skeleton-like (25-50% skeleton) and a reduced edaphic volume.
Soil profile in case of lithic sub-type is of Ao-Bv(R)-R, moderately superficial (21-50 cm), weak-strong skeleton-like (less than 25-75%) and a low-average edaphic volume.

**Physical Properties**

Texture in the Ao horizon is moderate sandy clay - silty clay (13.3-31.9% clay $<$ 0.002 mm) and silty sandy clay-silty clay (16.7-30.8% clay $<$ 0.002 mm) along the profile. Occasionally turns into coarse gritty clay in C/R.
Apparent density is very low to low in Ao (0.71-1.34 $g/cm^3$) and extremely low-high along the profile (0.87-1.54 $g/cm^3$). Consequently, total porosity is high-extremely high in Ao (50-62%) and moderate-extremely high along the profile (48-62%); total porosity in the Cn horizon has very low-average values (35-43%). The degree of settlement shows values of 25...+05 (very loose-poorly settled) in the surface horizon and +15...-15 (moderately settled-loose) along the profile. In this case, the soil penetration resistance is very low-low

all along the profile and the hydraulic conductivity is average-very high (K 5.2-125.3 mm/h) in Ao and low-very high (2.0-106.2 mm/h) along the profile.

**Chemical Properties**
Chemical properties are dependant on the parent material characteristics and soil development: use, vegetation etc.
Humus content is low-high in Ao (2.4-9.7%) and maintains in the subjacent horizon (1.6-5.8%), resulting in an organic matter (humus) reserve over the 0-50 cm depth of 110-252 t/ha (low-high), depending on the local conditions.
Soil reaction varies from strong to moderate acidic along the profile ( $pH_{H_2O}$ 4.7-5.8).
Exchangeable base sum is low-very low (4.3-12.3 me/100g soil) in Ao and extremely low-low along the profile (2.5-15.6 me/100g soil).
Cation exchange capacity T (SB+SH) is low-average (19.2- 26.9 me/100g soil) in Ao and very low-average along the profile (9.9-26.3 me/100g soil). Consequently, soils are debasified, the percentage of saturation in bases (V) falling into the oligobasic-mesobasic range in Ao (20-61%) and 17-71% along the profile.
Variable Al content ($Al^{3+}$) is very low-high (0.4-5.6 me/100g soil) in Ao and low-very high (1.7-7.5 me/100g soil) along the profile.
Nitrogen content is very low-very high (0.048-0.586%), generally low-average (0.116-0.209%).
Mobile phosphorus content ($P_{AL}$) is extremely low-very high (3-365 ppm), frequently only traces of this element occur.
Mobile potassium ($K_{AL}$) content is very low - very high (46-625 ppm) in Ao and subjacent horizon.
The soils are primarily used as meadows (grass and grazing lands) exploited in a traditional manner; the forests cover only small areas.

### *4.2.5 Andi Acid Bruni Soils - BOan - (Andi-dystric Cambisols) and Lithic Andi Acid Bruni Soils - BOan-ls - (Andi-lepti-dystric Cambisols)*

These soils occur in areas with deposits deriving from intermediate igneous rock alteration predominantly andesitic of the sedimentary volcanic formations.
Their dissemination is stricctly related to the above mentioned deposits as a result of the activity of volcanic and subvolcanic bodies in the Roşia Montană region, specifically around the Cetate and Carnic Massifs. The soils can be found on ridges, elevated planes, uneven short or long very shallow-steep slopes (slope gradient of 2-25%) and occur in pure units or associated with typical lithosols and locally with cambi andisols (soils with a Au-A/B-Bv-C/R morphology, dark colored, formed on materials resulting from volcanic rocks (andesite) alteration.
Soil profile is of Ao-Bv-C or R and Ao-BvR-R type, soils are moderately superficial to very deep ($d_2$-5), depending on the site characteristics. In these conditions, the soils are weak to strong skeleton-like ($q_1$-4), occasionally excessively skeleton-like ($q_5$) in case of lithic sub-type. They differ from the typical acid bruni soils due to the pH value in Fna compared to $pH_{H_2O}$. Thus, soil reaction is strong-moderate acidic ( $pH_{H_2O}$ 4.6-5.5), while the reaction at NaF determination is very strong alkaline ($pH_{NaF}$9.5-9.9), justifying their andic character.
Other physical, chemical and morphologic properties fall within values characteristic to bruni acid soils.
The soils are primarily used as grassland and meadows, occasionally areas covered by these soils are affected by mine waste depositions.

### *4.2.6 Typical Regosoils - RSti - (Eutric Regosols)*

**General Description**
These superficial soils with reduced thickness (maximum 20-30 cm) formed on deposits of unconsolidated materials of various sources: argillaceous gritty flysch, clay and argillaceous marls and even andesite detritus. They occur on confined, discontinuous areas, in monotype units or in association with other soil types or even rock outcrops.
These soils occur on hills, narrow ridges and uneven short or long moderate-very steep slopes.

Soil profile is of Ao-Cn type. The parent material is maintained close to the surface by geological erosion, the soil being in dynamic balance (climax) with the surrounding environmental elements.

**Physical Properties**

The texture of the Ao horizon with a thickness of de 5-15 cm is moderate sandy clay - moderate clay (16.7-28.2% clay $<$ 0.002 mm), turning to moderate argillaceous clay (41.5-43.3% clay $<$ 0.002 mm) at depth.

Apparent density is extremely low-moderate in Ao (1.03-1.41 g/cm$^3$) and high-very high at depth (1.51-1.61 g/cm$^3$). Total porosity is high-extremely high in Ao (47-62%) and very low-low below the Ao horizon (40-44%).

The soil is moderately settled and the penetration resistance is very low-moderate (8-40 kgf/cm$^2$) in Ao and high (52-60 kgf/cm$^2$) at depth. Hydraulic conductivity is very high-average in Ao (55.4-4.4 mm/h) and very low below this horizon (0.3 mm/h).

**Chemical Properties**

The humus content is average-high in the Ao horizon (4.4-7.4%) and decreases to low at depth (2.7%).

R Soil reaction is weak acidic in Ao, ( $\mathrm{pH}_{\mathrm{H_2O}}$ 6.1-6.2) turning into neutral - weak alkaline at depth ( $pH_{H_2O}$ 7.0-8.2).

Nitrogen content is moderate-high in Ao (0.239-0.570%) and very low in other horizons (0.082%). The soil is poorly supplied with mobile phosphorus with extremely low-very low contents (3-6 ppm) in the Ao horizon and low contents (13 ppm) in other horizons. The mobile potassium content is low to moderate (100-181 ppm).

Soil cation exchange capacity in the Ao horizon is moderate-high (24.6-29.8 me/100g soil) and low-moderate (14.0-17.2 me/100g soil) in the subjacent material. The soil is eu-basic, the percentage of saturation in bases varies between 86% and 100%.

The soils are primarily used as grassland, low quality forests, occasionally these types of soils develop on mine waste.

### *4.2.7 Typical Colluvisols - COti - (Fluvisols)*

Similar to regosols, colluvisols are non-evolved soils, with a profile of type Ao-C or C. Ao horizon is formed on colluvial material accumulated at the bottom of slopes in a layer over 50cm thick. Parent and subjacent material consist of clays and clays with skeleton.

Soil texture in Ao horizon and along the profile is argillaceous and the soil is low-moderate skeleton-like.

Soil physical and chemical properties are largely dependant on the characteristics of the materials they developed from.

These soils were encountered on limited areas in the north-eastern extremity, at the bottom of the slopes surrounding one of the largest lake in the area.

### *4.2.8 Typical Lithosols - LSti - (Eutri-lithic-Leptosols)*

**General Description**

These soils formed on various types of deposits: andesitic detritus, gritty flysch, argillaceous flysch, even waste rock with different texture, physical and chemical properties. They occur on narrow ridges, short or long uneven slopes over limited, discontinuous areas in association with other types of soils, as the second element, or with surface rocks.

Soil profile is of Ao-R type (hard rock), lithic contact occurring in the first 20 cm which restricts the thickness of the Ao horizon to 5-15cm.

**Physical Properties**

Texture of Ao horizon vary from moderate sandy clay to moderate clay (14.5-31.4% clay $<$ 0.002 mm), and the apparent density is extremely low (1.04 g/cm$^3$). Total porosity is extremely high 61.2%), the soil being very loose (GT -25) and with a very low penetration resistance 7 kgf/cm$^2$).

**Chemical Properties**
Lithosols developed within meadows and have an average to high organic matter (humus) content (3.8-7.4%) in the first 5-8 cm (fallow Ao horizon) and low content (1.4-2.7%) below this depth.
Soil reaction is strong to weak acidic ( $pH_{H_2O}$ 4,9-6,7); lithosols developing on intermediate volcanic rocks have andic character ($pH_{NaF}$9,7-10,0).
Nitrogen content is average (0.195-0.261%), and mobile P an K supply is extremely low-very low (3-5 ppm) and low-average (73-141 ppm), respectively. Catione exchange capacity is generally average (18.4-26.0 me/100 g soil) and as per the percentage of saturation in bases (55,1-77,0%) lithosols are mesobasic to eubasic. Lithosols developing on sandy flysch, in association with acid bruni soils (BOti, LSti) are oligomesobasic to oligobasic.

### *4.2.9 Variation of Some Properties of the Top Layer (Horizon) of Soils in the Region*

**Texture and Skeleton Content in the Top Layer (A)**
These properties are described in the texture and skeleton content in the upper horizon (A) chart, scale 1:10000, prepared for this purpose.
The chart shows the following:

- The A horizon soils with clayish texture and low-moderate skeleton content (lq1, lq1-2, lq2) are predominant covering an area of approximately 1017 ha (57.0%); they cover all interfluve between the Corna Valley and northern boundary of the region, laying over colluvial-delluvial deposits of various origins and properties occurring as a result of calcareous sandy flysch, frequently schistose, marls deposits or magmatic rocks (dacite, andesite) and volcanic-sedimentary formations. Within this area, the topography is uneven with varying local slopes. Soils with clayish texture and no skeleton in the A horizon cover an area of about 57 ha (3.2%) in the north-western part of the region (north of Roşia Valley).
- Soils with clayish-sandy texture and low-excessive skeleton content (sq1...sq2-4) in the A horizon cover an area of about 259 ha (14.30%) and are located near the main volcanic bodies or along the Corna Valley not far from these bodies mixed with sandy and/or andesitic detritus, on slopes or ridges.
- Soils with a clayish sandy - clayish texture and a low-moderate skeleton content (s-lq1-2) in the A horizon are extensive (424 ha-24.0%), rarely without skeleton (s-l) - about 7 ha (0.4%); this type of soils cover the interfluve left of Corna Valley down to Carnic, on the right side of the valley; the deposits are similar to the deposits in the clay-sandy texture class.

**Fertile Layer Thickness in View of Land Amenability to Stripping**
This property is illustrated on the strippable area map with specification of the fertile layer thickness, 1:10000 scale.
The map shows that approximately 465.9 ha (26.1%) of the region is not amenable to stripping. These soils with a fertile layer less than 10 cm thick lie in the valleys and lands near the two volcanic bodies Cetate and Carnic covered by thin (not deep) soils with lithic or skeleton character in association with lithosols or regosols. Areas not stripped in the 2,3,4,5 category also occur.
The soil class with a fertile layer of 10-20 cm is widely spread over zones with clayish sandy to clayish texture in the interfluves left of the Corna Valley and north of the Cetate-Carnic volcanic complex, covering an area of 460.5 ha (25.8%).
The areas with a fertile layer thickness of 10-30 cm and 20-30 cm (3;4) cover a relatively equal area of 486.7 ha (27.3%) and 307.1 ha (17.2%), respectively. Category 3 is frequently encountered in the south, south-east and north east part of the region over soils

of varying thickness associated with regosols or lithosols, while category 4 prevails in the western half of the region over similar soils. Here, the bio-accumulation process was preferential.
Areas with the thickest fertile layer belong to categories 5, 6, 7 covering a total area of 64.8 ha (3.6%), 5: 51.5 ha (2.9%), 6: 8.5 ha (0.5%) and 7: 4.8 ha (0.2%), respectively. They are areas with deep soils and a well-developed bio-accumulation horizon.
We specify that the 10cm thickness is considered the minimum thickness below which stripping may not be carried out due to the risk of carrying over of non-fertile material with varying skeleton content or of encountering boulders and/or compact rocks located occurring the surface.

**Organic Matter (Humus) Reserve Over the 0-50 cm Depth**
It is shown on the 1:10000 scale chart in the Study.
Soils with very low-low humus reserve (30-55 t/ha and 70-145 t/ha) lie over an area of 780 ha (43.7%) and cover the valleys and lands with a fertile layer 10-20cm and 10-30cm thick and clay sandy - clay texture.
Soils with a moderate (medium) humus reserve (164-244 t/ha) are the widest spread, covering an area of 869 ha (48.7%); they lie over areas with a thicket bio-accumulation horizon (20-30 cm).
Areas of soils with a large humus reserve (252-259 t/ha) and thick fertile layer (20-40 cm), and a higher accumulation of organic matter are most limited, covering approximately 136 ha (7.6%). This property and the texture in Ap or in the 0-20 cm layer are two eco-pedologic indicators which in normal conditions have an effect on the quality grade.

## 4.3 Agrichemical Characterization of Soil Overburden

### *4.3.1 General*

Data regarding the soil agrichemical properties are very important for adopting of a fertilization technique intended to provide optimum nutrition of the grown plants, prevention of soil, water, agricultural products contamination, protection and use of the stripped fertile soil upon the removal from the agricultural circuit of areas of land required for investment projects, as well as utilization of the stripped fertile soil for environmental rehabilitation of sites with degraded soils etc.
For this purpose, site agrichemical mapping consists of activities such as outlining of plots similar with respect to soil type, crop, fertilization method etc., average soil sample collection from the outlined plots, agrichemical assays in laboratory and illustration on charts of land areas with similar agrichemical properties.
The conducted agrichemical mapping aimed to describe the soil fertility in the area owned by S.C. ROŞIA MONTANĂ GOLD CORPORATION S.A. and neighboring areas to be impacted by the gold mining operations by open pit mining.
A total of 103 samples were collected over an area of about 1785 ha for the purpose of agrichemical mapping of the Roşia Montană region. Samples were collected as average agrichemical samples, consisting of 45-50 partial samples collected using an Orth agrichemical auger over a depth of 15-25 cm, depending on the thickness of the A horizon or soil layer above the parent material (rock).
At the marking out of the agrichemical plots (plots wherefrom average agrichemical samples were collected) the following were taken into consideration: significant natural boundaries (roads, streams, major valleys etc.), vegetation condition, soil layer thickness and areas considered of different fertilization achieved mainly with natural fertilizers (farmyard manure, gardens in the built-up area are better fertilized in order to obtain larger agricultural crops, particularly vegetables, potatoes etc.).
Following sample preparation in the soil chemistry laboratory specific assays for soil reaction and fertility description in terms of organic matter, nitrogen, phosphorus and potassium supply were carried out. The following were determined:

a) pH, in water slurry at a 1/2.5 soil/water ratio, potentiometer with a couple of electrodes of calomel glass;

b) Phosphorus and potassium content, mobile forms, determined using the Egner-Riehm-Domingo method, in ammonium lactate acetate extract ($P_{AL}$ and $K_{AL}$); the results are given in ppm;

c) Exchangeable base sum - SB and hydrolytic acidity - Ah, using Kappen methos; the results are given in me/100 g soil;

d) Organic matter (humus) content using the oxidimetric method in Walkley-Black variant, modified by Gogoasa; the results are given in %.

Agrichemical charts for soil reaction, supply of soil with organic matter, nitrogen, phosphorus and potassium were drawn up by recording the assay values next to the sample number from each sampling plot.
Each plot was colored according to the appropriate range of reaction or organic matter, phosphorus and potassium supply, as per the legend attached to each chart.
The summaries for agrichemical indexes pH, IN, P, K were prepared by grouping the area of the samples falling within a reaction or supply range (samples shown on charts with the same color) and their percentage reporting.

### *4.3.2 Soil Reaction (pH)*

Soil reaction is one of the most important soil properties, as medium for plant growth, as here various organic, organic-mineral and mineral compounds colloidal dispersed or dissolved can be found, compounds that are very important for plant nutrition.
The pH value determined in the laboratory is significant for the general characterization of soils and agricultural practices as plant and microorganisms in soil live and develop within certain pH levels and mobility of nutrient elements involved in plant nutrition is strongly affected by soil reaction.
A review of the pH agrichemical summary and chart shows that from a reaction standpoint the soil distribution is as follows:

**Mapped area: 1785ha, of which:**

| | | |
|---|---|---|
| - soils with reaction | - **strong acidic:** | 928 ha, representing 52.0% |
| - soils with reaction | - **weak acidic:** | 718 ha, representing 40.2% |
| - soils with reaction | - **neutral:** | 104 ha, representing 5.8% |
| - soils with reaction | - **weak alkaline:** | 35 ha, representing 2.0% |

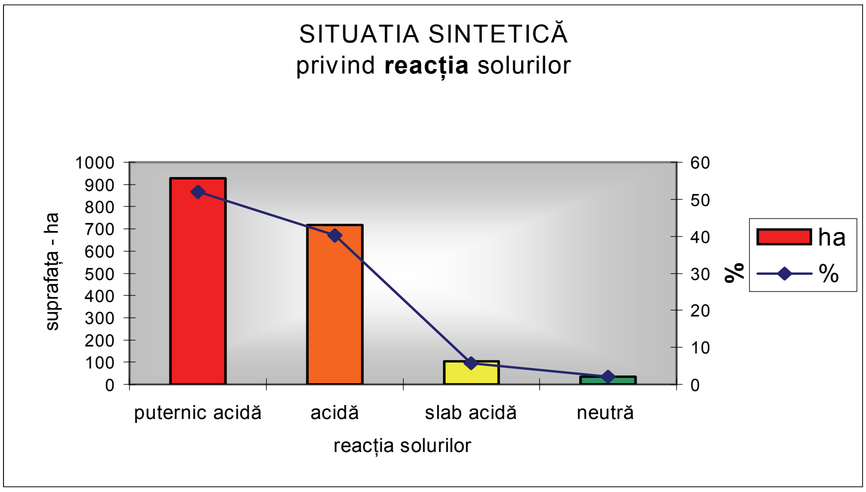



**Figure 4.1. Frequency of soil distribution as a function of the soil reaction type**

In order to convert these soils to pH values favorable for plant growth (weak-acid, neutral reaction) it is required to perform a soil amendment with calcium carbonate over more than 50% of the area.

### *4.3.3 Soil Content in Organic Matter*

Organic matter (humus) in the soil is the main nitrogen supply source for the plants which stores over 90% of the total nitrogen reserve in the plowed layer. Under the influence of soil microorganisms the organic matter is mineralised resulting in the release of nitrogen and its conversion in forms suitable for plants.

A review of the organic matter content levels (humus - %H) and grouping the soils as per the range limits shows that from a organic matter supply standpoint the soil distribution is as follows:

A review of the organic matter content levels (humus - %H) and grouping the soils as per the range limits shows that from a organic matter supply standpoint the soil distribution is as follows:

**Mapped area: 1785 ha, of which:**

- soils with **medium content:** 823 ha, representing 46.1 %
- soils with **high content:** 945 ha, representing 52.9 %
- soils with **very high content:** 7 ha, representing 1.0 %

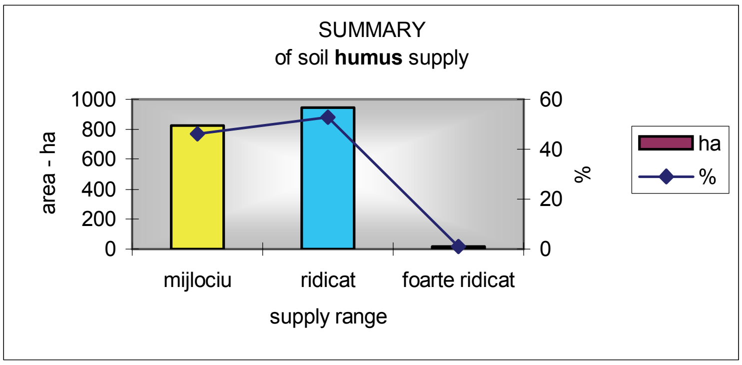



**Figure 4.2. Frequency of soil distribution as a function of the organic matter content**

We must specify that the organic matter content is apparently high. Actually, soil C organic content (analytically determined) is high, deriving both from humus itself and organic residues (roots mainly) in various decomposition phases.

### *4.3.4 Soil Nitrogen Supply*

The nitrogen supply level of the soil was determined indirectly using the nitrogen index values (IN). This is the result of the multiplication between the organic matter content (humus) and percentage of saturation with bases, all divided by 100. The IN values were used for drawing up of the nitrogen supply chart within the investigated site.

This data shows that 4% of the area is covered by poorly nitrogen supplied soils; 32% - moderately supplied; 56% - well supplied and 8% - very well supplied.

### *4.3.5 Soil Mobile Phosphorus Supply*

Phosphorus is extremely important for plant growth, having an energetic and structural role in the cell and in conjunction with the nitrogen facilitates the general growth of plants and particularly of the radicular system. Phosphorus is also the element required for a normal nitrification process which can be obstructed or inhibited in soils poor in phosphorus.

The chart and agrichemical summary drawn up for characterization of soil phosphorus supply show the following:

**Mapped area: 1785 ha, of which:**

- soils **supplied:** 1277 ha, representing 71.5 %
- soils **poorly supplied:** 438 ha, representing 24.5 %
- soils **moderately supplied:** 5 ha, representing 2.0 %
- soils **well supplied:** 5 ha, representing 2.0 %

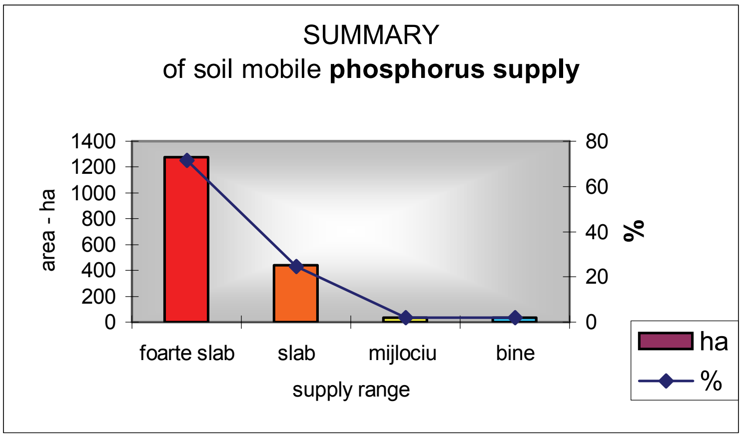



**Figure 4.3. Frequency of soil distribution as a function of the soil mobile phosphorus supply**

It can be noted that 96% of the investigated area is covered by soils with very poor - poor phosphorus supply. In order to develop a suitable agriculture, mineral fertilizers with phosphorus and organic fertilizers are required.

### *4.3.6 Soil Mobile Potassium Supply*

Potassium along with the other mineral elements in the soil participates in and acts upon the growth and development functions and provides the plants with resistance to various damaging factors (resistance to extreme temperatures, illness, pests, etc). It is found in soil in various forms of which the soluble and alterable forms are accessible to the plants however, the most important for the nutrition of the plants is the alterable form as the soluble one is normally present in very low concentrations.

Determination of potassium accessible to the plants allows for determination of the soil fertility and doses of potassium fertilizers.

The followings derive from the agrochemical map and situation developed to characterize the soil potassium supply:

**Mapped area: 1785 ha, of which:**

- **averagely supplied** soils: 525 ha, representing 29.4 %
- **suitable supplied** soils: 1120 ha, representing 62.8 %
- **very well supplied** soils: 140 ha, representing 7.8 %

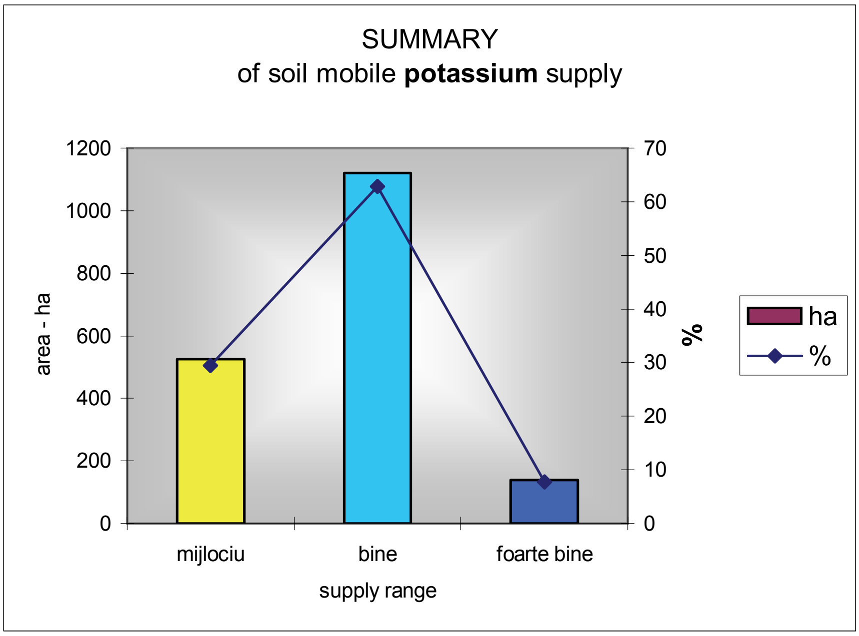



**Figure 4.4. Frequency of soil distribution as a function of the soil mobile potassium supply**

Due to the parent material rich in potassium elements, the soils in the area are well supplied with this nutrient.

## 4.4 Microbiological Characterization of the Overburden

The microbiological tests aimed to estimate the densities of the colony forming units within the fungi groups and number of viable colony forming cells within the bacteria group, determine the taxonomic composition of the populations of microorganisms present in the respective soils, determine the soil respiration level as an overall indicator of the physiological activities carried out by the edaphic micro-flora as well as assess the importance of certain species for the circuit of the soil organic matter or for the life of the plants.

Variability from small numbers to very large numbers was determined in terms of soil load in colony forming fungi structures (ufc) of spores, hypha, sclerotium type.

The evaluations regarding the amount of viable bacteria cells indicated a similar situation. Thus, the largest number of bacteria was highlighted in profile P5 (0-18 cm) of 427.3 x $10^6$ viable cells/g of dry soil, followed by profile P26 (0-6 cm) of 384.1 x $10^6$ viable cells/g of dry soil, however these values do not represent the maximum concentrations of the bacterial micro-flora in soils (Table 4-2). Apart from the quantity development in these horizons the soil conditions have facilitated an increased level of the bacterial species biodiversity, with an increase in the frequency of *Mycobacterium sp., Pseudomonas sp., Arthrobacter globiformis, Bacillus circulans* species having been noted.

Accordingly, the large number of Mycobacterium species in conjunction with Arthrobacter species indicates a more advanced stage of organic matter recycling.

The largest number of fungi was recorded at P2 P2 (0-5 cm) and was of 305.686 x $10^3$ ufc/g of dry soil, value that is deemed very high in soils. Given that the next horizon (5-19 cm) is populated with an average number of fungi it is possible that towards the surface the

high values to be the result of certain special conditions facilitating the abundant development of the Fusarium and Penicillium species which are already known as intense producers of breeding elements capable of developing numerous colonies (Table 4-1). Such conditions could be an excess of organic matter of vegetal origin that is under decomposition, presence of polluting substances or invasive development of the Fusarium species on herbaceous plant roots.
The soil respiration levels, two times higher than in the deeper levels, indicate the significant contribution of the fungi in $CO_2$ removal in horizon At (0 – 5 m).
The large number of fungi (between 100 and 200 x $10^3$ ufc/g of dry soil) was determined in 3 samples: P30 at 5-22 cm (161.453 x $10^3$ ufc/g of dry soil), P1 at 0-5 cm (102.480 x $10^3$ ufc/g of dry soil) and P14 at 0-5 cm (111.959 x $10^3$ ufc/g of dry soil).
Average values of the bacterial micro-flora were recorded in profiles P25, P23 and P20, ranging between 102.2-261.9 x $10^6$ viable cells/g of dry soil. In terms of the load of soil in bacterial structures the remaining profiles (34) are rated into the low values category (below 100 x $10^6$ viable cells/g of dry soil) where the quantitative variations were induced by the individual variations of the physical-chemical conditions in the respective soils also.
It must also be noted the very low level of bacterial micro-flora load for profiles P 11 and P34 where the quantitative evaluations were below 10 x $10^6$ viable cells/g of dry soil, a small biodiversity induced by the environmental factors having been noted as well. Under these conditions, the adaptation capacity, remodelling of the intensity of certain physiological processes for *Bacillus cereus* var. *mycoidess* species at profile P11 and *Arthrobacter citreus*at profile P34 and certain Actiomicete facilitated the survival in the respective soils.
Average numbers of fungi were recorded on 14 profiles, e.g. between 50-100 x $10^3$ ufc/g of dry soil: P33, P34, P36, P38, P40, P2 (0-5 cm), P3, P6, P13, P19, P20, P22 and P25 (Table 4-1).
The remaining 23 samples, more than half of the total samples analysed are below 50 x $10^3$ ufc/g of dry soil, in the category of low soil load in fungi structures.
In terms of the release of $CO_2$ in soil, micro-flora in the surface horizons from 3 profiles indicated an intense activity with high values of soil respiration of 109.690 mg $CO_2$/100g soil for P39; 92.85 mg $CO_2$/100g soil for P34 and 81.48 mg $CO_2$/100g soil for P5. The remaining 38 samples had average soil respiration values, ranging between 30 and 80 mg $CO_2$/100g soil (Table 4-1.).
For profiles in which there were two horizons analysed (P2, P7 and P15), the tendency for lower population in fungi micro-flora of the deep horizon compared to the surface horizon along with the reduction of the intensity of the physiological processes performed by the edaphic flora in general and release of smaller amounts of $CO_2$ in soil was noted.
The taxonomic measurements outlined the presence in soil of a number of species which for the majority of the options ranges between 2-4 fungi species and 1-9 bacteria species. In terms of the bacteria in the analysed profiles, the largest diversity was identified in profiles P25 and P5 (9 and 8 species, respectively) and the lowest diversity in profiles P11 and P34.
The number of bacteria species was in relation with the quantitative value of the bacteria community in the respective profiles with a balance between the variation trend of the number of species and number of viable cells having been maintained and with a balance in the analyzed profiles between the dimensions of the edaphic communities and their diversity having been highlighted.
Generally, the isolation frequency of the bacteria in the soil profiles was 26.8% for Bacillus and Arthrobacter species, 26.1% for Pseudomonas species, 12.6% for Mycobacterium species and 7.4% for Actinomicete species. Accordingly, there may be noted that within the Bacillus genus there are variances in the occurrence frequency of the species in the analyzed soils. Thus, the highest frequency (25.9%) was recorded for the *Bacillus circulans* species, followed by *Bacillus megaterium* (22.2%), *B. cereus var. mycoides* (18.5%), *B. cereus* (16.04%), *B. sphearicus* (9.8%) and *B. polymixa* (7.4%); (Table 4-2.).

The isolated bacterial species are typically eda-phosphorous, some even having Ubiquarian spectrum. The more diversified micro-flora with a larger spectrum of micro-organism species are involved in the carbon circuit (species of the Bacillus genus), potassium, phosphor circuit or with proteolithic properties (*Bacillus cereus, B. megaterium, Pseudomonas sp.*). There were no species having pathogen potential for plants identified.
The number of fungi species was generally related to the quantitative level of the fungi communities in the respective samples, in the sense that balance was maintained between the variation tendency of the number of species and that of the number of fungi units forming colonies.
This indicates the presence of balanced structures of edaphic fungi communities in the analysed profiles, keeping control over the diversity-homogeneity balance.
Thus, for samples in profiles P2 and P29, the great values of the fungi community dimensions were accompanied by a balanced distribution on the 7 and 6, respectively species comprising the population, whilst the communities in small number profiles, e.g. around 10 x $10^3$ ufc/g of dry soil comprised of representatives of one single species, e.g. sterile miceli of a *Dematiaceae* species from P37; *Stachybotrys chartarum* species at P15 in horizon 0-10 cm and *Fusarium culmorum* in the sub-adjacent horizon of the same profile; *Verticillium leccani* at P28.
The isolation frequency shows that representatives of the Fusarium genus were identified in 50% of the samples and Penicillium species in 47.5%, this genus generally being the most abundant in fungi communities of the majority of the soils where they are typically the dominant species.
The Aspegillus genus, represented by 4 species was isolated in 17.5% of the samples and Trichoderma with *T. viride, T. lignorum* and *T. koningii* species was isolated with equal frequency to *Zygorhynchus moelleri* (15% of the samples).
In terms of the ecology of the species, there were isolated both typical eda-phosphorous species, common for the soils in our countries e.g. *Penicillium janthinellum* si *Humicola grisea*, as well as a number of species which develop well and are frequently identified in rizosphere, e.g. *Fusarium oxysporum, Mortierella isabellina, Paecilomyces marquandii, Zygorhynchus moelleri, Cladosporium* sp., or *Alternaria alternata,* often encountered underneath graminaceae grass land and which is the dominant species at P38, P40 and P22.
An important group of species are those contributing to the recycling of the vegetal organic matter, such as the species within the Trichoderma genus with complex enzymatic abilities and high adaptability to various soil conditions, which dominates the fungi communities in samples P6, P18, P19 and P21, *Myrothecium roridum* (P6), *Zygorhynchus moelleri* dominant in P33, P15 and P10, *Fusarium oxysporum* dominant in P36 and P39 as well as species of the Cladosporium, Alternaria or Humicola genus, which contribute to the formation of humus and aggregation of soil particles via hypha.
Another aspect is that regarding the relations between the potentially phytopathogen species (which in case of nutritive unbalance or natural or anthropogenic disturbance may affect the health of the plants) and the microbial antagonists in the soil. Thus, of the identified species some may adopt, apart from saprophyte feeding, a parasite lifestyle affecting a number of vegetal species. This is the case with the Fusarium (*F. Culmorum, F. pallidoroseum, F. oxysporum, F. avenaceum*) and Phytophtora (*F. Culmorum, F. pallidoroseum, F. oxysporum, F. avenaceum*) species.
Generally, these species are encountered in very small number in the analyzed profiles at the poorer communities and most times their presence is accompanied by antagonists within *Trichoderma viride* (for P29, P6, P18, P23) or *Gliocladium roseum* species for P7 (0-4 cm).
In conclusion, the investigated soils are generally poorly or averagely populated with fungi or bacterial micro-flora, have a relatively moderate diversity e.g. 2 - 4 species for fungi and 1 – 9 species for bacteria and relatively balanced, homogenous taxonomic communities.

The most frequently isolated fungi species belong to Fusarium, Penicillium, Aspergillus and Trichoderma genus and the most frequently isolated bacteria species belong to Bacillus, Arthrobacter and Pseudomonas, which are typical for the soil in our country and do not pose significant problems from a phyto-sanitary standpoint.

The overall physiological activities of the edaphic micro-flora indicate average intensity for the majority of the investigated profiles with soil respiration values ranging between 30-80 mg $CO_2$/100g soil and significant for 3 profiles (over 80 mg $CO_2$/100g soil).

## Table 4-1. Soil respiration and composition of fungi micro-flora in the Roşia Montană area soils

| No. | Profile | Depth (cm) | Soil Respiration mg $CO_2$/100 g d.s. | Fungi No. x $10^3$ ufc/g d.s. | Specific Composition of Fungi Micro-Flora |
|---|---|---|---|---|---|
| 1 | P1 | 0 - 5 | 78.66 | 102.480 | Fusarium oxysporum, Aspergillus versicolor, Phoma glomerata |
| 2 | | 6 - 15 | 59.83 | 60.759 | Fusarium culmorum, Aspergillus versicolor |
| 3 | P2 | 0 - 5 | 71.87 | 305.686 | Fusarium culmorum, Absidia corymbifera, Penicillium frequentans, Acremonium strictum, Penicillium vermiculatum, Aspergillus terreus, Aspergillus versicolor |
| 4 | | 5 - 19 | 32.90 | 51.041 | Fusarium culmorum, Cladosporium herbarum, Verticillium leccani, Penicillium vermiculatum |
| 5 | P3 | 4 - 16 | 71.87 | 50.556 | Penicillium thomii |
| 6 | P4 | 4 - 16 | 56.73 | 20.348 | Penicillium albidum, Penicillium vermiculatum |
| 7 | P5 | 0 - 5 | 81.48 | 40.796 | Fusarium equiseti, Verticillium leccani, Fusarium sp. |
| 8 | P6 | 0 - 10 | 61.74 | 60.766 | Trichoderma viride, Myrothecium roridum, Fusarium avenaceum |
| 9 | P7 | 0 - 4 | 77.22 | 41.123 | Gliocladium roseum, Fusarium pallidoroseum |
| 10 | | 4 - 13 | 64.60 | 20.421 | Cladosporium macrocarpum, Humicola grisea |
| 11 | P8 | 0 - 20 | 52.20 | 30.131 | Absidia corymbifera, Penicillium lilacinum |
| 12 | P10 | 0 - 12 | 62.10 | 40.800 | Zygorhynchus moelleri, Fusarium pallidoroseum |
| 13 | P11 | 3 - 18 | 70.95 | 20.525 | Fusarium pallidoroseum, Acremonium strictum |
| 14 | P12 | 5 - 23 | 53.28 | 10.250 | Stachybotrys chartarum |
| 15 | P13 | 5 - 1 | 72.46 | 50.948 | Penicillium griseofulvum, Micelii sterile de Dematiaceae |
| 16 | P14 | 0 - 5 | 77.71 | 111.959 | Absidia corymbifera, Verticillium leccani, Aspergillus glaucus |
| 17 | P15 | 0 - 10 | 72.62 | 10.229 | *Zygorhynchus moelleri* |
| 18 | | 10 - 20 | 61.67 | 10.245 | *Fusarium culmorum* |
| 19 | P18 | 0 - 20 | 68.19 | 40.688 | *Trichoderma viride, Fusarium oxysporum, Alternaria alternata* |
| 20 | P19 | 0 - 20 | 78.10 | 71.283 | *Trichoderma viride, Cunninghamella elegans* |
| 21 | P20 | 0 - 20 | 79.73 | 50.953 | *Aspergillus terreus, Penicillium griseofulvum* |
| 22 | P21 | 0 -20 | 73.91 | 30.380 | *Trichoderma koningii, Zygorhynchus moelleri* |
| 23 | P22 | 0 - 20 | 51.17 | 51.172 | *Alternaria alternata, Gliomastix murorum, Penicillium lilacinum* |
| 24 | P23 | 0 - 20 | 68.89 | 20.360 | *Fusarium culmorum, Trichoderma viride* |
| 25 | P24 | 0 - 20 | 65.16 | 40.933 | *Penicillium verrucosum, Fusarium sp., Verticillium leccani, Phytophthora* sp. |

| No. | Profile | Depth (cm) | Soil Respiration mg $CO_2$/100 g d.s. | Fungi No. x $10^3$ ufc/g d.s. | Specific Composition of Fungi Micro-Flora |
|---|---|---|---|---|---|
| 26 | P25 | 0 - 20 | 66.56 | 60.711 | *Penicillium griseofulvum, Alternaria alternata, Verticillium leccani, Fusaium* sp. |
| 27 | P26 | 0  -20 | 51.76 | 20.379 | *Phytophthora* sp., *Zygorhynchus moelleri* |
| 28 | P27 | 0 - 20 | 67.96 | 30.647 | *Phyalophora fastigiata, Fusarium oxysporum, Penicillium verrucosum* |
| 29 | P28 | 0 - 20 | 63.41 | 10.195 | *Verticillium leccani* |
| 30 | P29 | 5 - 22 | 35.04 | 161.453 | *Penicillium lilacinum, Fusarium oxysporum, Penicillium thomii, Trichoderma lignorum, Penicillium griseofulvum, Verticillium leccani* |
| 31 | P30 | 0 - 20 | 63.05 | 40.729 | *Hyalopus ater, Penicillium restrictum* |
| 32 | P31 | 7 - 22 | 61.55 | 40.891 | *Mortierella isabellina, Penicillium griseofulvum, Zygorhynchus moelleri, Penicillium purpurescens* |
| 33 | P32 | 0 - 19 | 66.56 | 40.568 | *Fusarium avenaceum, Penicillium vermiculatum, Cladosporium herbarum, Penicillium albidum* |
| 34 | P33 | 0 - 18 | 66.39 | 50.989 | *Zygorhynchus moelleri, Aspergillus terreus, Penicillium thomii* |
| 35 | P34 | 0 - 20 | 92.85 | 50.958 | *Fusarium sp., Alternaria alternata, Aspergillus glaucus* |
| 36 | P35 | 0 - 18 | 65.43 | 20.184 | *Penicillium albidum, Penicillium thomii* |
| 37 | P36 | 0 - 20 | 32.78 | 80.906 | *Fusarium oxysporum, Phytophthora* sp., *Alysidium fulvum* |
| 38 | P37 | 0 - 20 | 35.16 | 10.439 | *Mycelia sterilia* |
| 39 | P38 | 0 - 20 | 69.48 | 60.877 | *Alternaria alternata, Penicillium janthinellum* |
| 40 | P39 | 0 - 20 | 109.69 | 20.292 | *Fusarium oxysporum, Alternaria alternata* |
| 41 | P40 | 0 - 15 | 67.49 | 86.749 | *Alternaria alternata, Paecilomyces variotii, Aspergillus* sp., *Absidia corymbifera, Stachybotrys chartarum* |

## Table 4-2. Composition of bacteria micro-flora in the Roşia Montană area soils

| No. | Profile | Depth (cm) | Bacteria No. x $10^6$ viable cells/g d.s. | Specific Composition of Bacteria Micro-Flora |
|---|---|---|---|---|
| 1 | P1 | 0 - 5 | 18.4 | Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis, Arthrobacter simplex, Mycobacterium sp. |
| 2 | | 6 - 15 | 8.1 | Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis, Bacillus circulans |
| 3 | P2 | 0 - 5 | 15.3 | Pseudomonas sp., Bacillus circulans, Arthrobacter globiformis |
| 4 | | 5 - 19 | 17.3 | Bacillus cereus var. mycoides, Pseudomonas sp., Bacillus circulans |
| 5 | P3 | 4 - 16 | 12.1 | Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis |
| 6 | P4 | 4 - 16 | 12.2 | Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis |
| 7 | P5 | 0 - 5 | 427.3 | Arthrobacter globiformis, Bacillus circulans, Bacillus cereus, Bacillus megaterium, Arthrobacter oxydans, Bacillus polymyxa |
| 8 | P6 | 0 - 10 | 12.2 | Pseudomonas sp., Arthrobacter citreus, Arthrobacter globiformis |
| 9 | P7 | 0 - 4 | 21.6 | Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis |
| 10 | | 4 - 13 | 30.6 | Pseudomonas sp., Bacillus circulans, Bacillus cereus, Bacillus megaterium, Arthrobacter globiformis, Bacillus sphaericus |
| 11 | P8 | 0 - 20 | 15.1 | Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis |
| 12 | P10 | 0 - 12 | 13.3 | Mycobacterium sp., Pseudomonas sp., Arthrobacter globiformis, Actinomicete |
| 13 | P11 | 3 - 18 | 1.0 | Bacillus cereus var. mycoides |
| 14 | P12 | 5 - 23 | 28.7 | Bacillus megaterium, Bacillus cereus, Pseudomonas sp., Arthrobacter globiformis, Mycobacterium sp. |
| 15 | P13 | 5 - 10 | 12.2 | Pseudomonas sp., Bacillus circulans |
| 16 | P14 | 0 - 5 | 19.3 | Pseudomonas sp., Bacillus circulans, Arthrobacter globiformis, Bacillus polymyxa, Actinomicete |
| 17 | P15 | 0 - 10 | 17.4 | *Arthrobacter citreus, Pseudomonas sp., Bacillus megaterium,* Actinomicete |
| 18 | | 10 - 20 | 11.3 | *Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis, Arthrobacter citreus* |
| 19 | P18 | 0 - 20 | 20.3 | *Pseudomonas sp., Arthrobacter globiformis,* Actinomicete |
| 20 | P19 | 0 - 20 | 19.3 | *Mycobacterium sp., Pseudomonas sp., Arthrobacter citreus, Bacillus circulans* |
| 21 | P20 | 0 - 20 | 261.9 | *Mycobacterium sp., Pseudomonas sp., Arthrobacter globiformis, Arthrobacter simplex, Bacillus circulans, Bacillus cereus, Bacillus megaterium* |
| 22 | P21 | 5 - 1 | 16.2 | *Bacillus circulans, Pseudomonas sp., Bacillus megaterium, Arthrobacter globiformis, Mycobacterium sp.* |
| 23 | P22 | 0 - 20 | 16.4 | *Pseudomonas aeruginosa, Bacillus sphaericus, Arthrobacter globiformis, Bacillus circulans* |

| No. | Profile | Depth (cm) | Bacteria No. x $10^6$ viable cells/g d.s. | Specific Composition of Bacteria Micro-Flora |
|---|---|---|---|---|
| 24 | P23 | 0 - 20 | 251.5 | *Mycobacterium sp., Pseudomonas sp., Arthrobacter citreus, Bacillus circulans, Bacillus polymyxa, Arthrobacter globiformis, Bacillus cereus, Bacillus megaterium, Bacillus sphaericus* |
| 25 | P24 | 0 - 20 | 37.9 | *Mycobacterium sp., Arthrobacter globiformis, Arthrobacter citreus, Pseudomonas sp.* |
| 26 | P25 | 0 - 20 | 102.2 | *Mycobacterium sp., Arthrobacter citreus, Pseudomonas sp., Bacillus circulans, Bacillus polymyxa, Bacillus megaterium, Arthrobacter globiformis, Bacillus cereus var. mycoides* |
| 27 | P26 | 0 - 20 | 384.1 | *Mycobacterium sp., Pseudomonas sp., Bacillus circulans, Bacillus cereus var. mycoides, Bacillus megaterium, Bacillus cereus, Bacillus polymyxa, Bacillus sphaericus* |
| 28 | P27 | 0 - 20 | 99.1 | *Arthrobacter globiformis, Pseudomonas sp., Bacillus circulans, Bacillus megaterium, Bacillus sphaericus* |
| 29 | P28 | 0 - 20 | 82.6 | *Mycobacterium sp., Pseudomonas sp., Bacillus circulans, Arthrobacter citreus, Arthrobacter globiformis* |
| 30 | P29 | 5 - 22 | 16.1 | *Bacillus cereus var. mycoides, Pseudomonas sp., Bacillus circulans* |
| 31 | P30 | 0 - 20 | 26.5 | *Bacillus circulans, Pseudomonas sp., Bacillus megaterium,* Actinomicete |
| 32 | P31 | 7 - 22 | 23.5 | *Pseudomonas sp., Bacillus circulans, Arthrobacter globiformis,* Actinomicete |
| 33 | P32 | 0 - 19 | 11.1 | *Bacillus cereus var. mycoides, Bacillus megaterium, Bacillus cereus, Bacillus circulans* |
| 34 | P33 | 0 -18 | 27.5 | *Pseudomonas sp., Arthrobacter globiformis,* Actinomicete |
| 35 | P34 | 0 - 20 | 27.5 | *Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis, Bacillus cereus* |
| 36 | P35 | 0 - 18 | 5.0 | *Arthrobacter citreus,* Actinomicete |
| 37 | P36 | 0 - 20 | 28.3 | *Bacillus cereus var. mycoides, Pseudomonas sp., Arthrobacter globiformis, Mycobacterium sp.* |
| 38 | P37 | 0 - 20 | 20.4 | *Mycobacterium sp., Bacillus megaterium, Arthrobacter citreus* |
| 39 | P38 | 0 - 20 | 58.8 | *Bacillus cereus var. mycoides, Bacillus megaterium, Bacillus cereus, Mycobacterium sp., Arthrobacter citreus, Arthrobacter globiformis, Bacillus circulans* |
| 40 | P39 | 0 - 20 | 60.9 | *Mycobacterium sp., Pseudomonas sp., Bacillus megaterium, Arthrobacter globiformis, Bacillus circulans, Bacillus sphaericus, Bacillus cereus,* Actinomicete |
| 41 | P40 | 0 - 15 | 69.6 | *Mycobacterium sp., Arthrobacter citreus, Pseudomonas sp., Arthrobacter globiformis, Bacillus circulans, Actinomicete, Bacillus polymyxa* |

## 4.5 Load of Overburden in Contaminants

Given that in the area are present ore deposits in which prevailing is Au and Ag, but in paragenesis there are other metal chemical elements that may occur, such as heavy metals, the contents of these chemical elements (e.g. Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn) in the soil samples collected in the genetic horizons of the soil types and subtypes were determined.

The statistical processing of the analytical data as parameters is presented in Table 4-3. for all soil types (153) and in Tabels 4-4. - 4-8. for various horizons. The returned results were compared to the reference values of MAPP Order/1997 regarding the normal contents of these chemical elements in soil and values representing alert and response thresholds for sensitive soil use. This type of use was employed because the soil in the area is nutrition support and media for the grassland and hay field plants and trees. Therefore, two direct nutrition sources for livestock and people.

A predominant feature of these analytical data is the fact that they have low values, generally below the alert or response thresholds. Thus, the maximum Zn content (272 ppm) is below the AT, between the normal value and AT, whereas the average value of 87.5 ppm is lower than the normal average content in soils. The Cu levels of 39 ppm and 18 ppm are similar to the Zn levels, in that are below the alert and response thresholds. In addition to the two heavy metals are the Cr levels.

Other heavy metals like Mn, Pb, Ni and Co have maximum values ranging between the alert and response thresholds and average values between normal value and alert threshold. The maximum values range is represented by few values, the majority being below the alert threshold.

Where Cd is concerned the maximum level exceeds by two times the response threshold, however the average level is low, e.g. ranging between the normal level and alert threshold, closer to the normal concentration. This demonstrates the singularity of the level of 10.1 ppm for Cd. Indeed, this level is found in a sample collected at the bottom of profile 26, e.g. horizon B/C. A second high level of 8.2 ppm is found in a sample collected in a Bv horizon of an adjacent profile, e.g. no. 27, which is a typical acid bruni soil.

These levels have been included in the database attached to this report, under chapter chemical analysis. Accordingly, the frequency of the heavy metals distribution in the overburden in the Roşia Montană area (figure 4.5- 4.7) clearly indicates that the distributions are asymmetrical leftwards. Therefore, the majority of the levels are within the low concentration range. Except for the Fe histogram which has a rightward asymmetry.

Similar conclusions are reached where the static parameters of the total heavy metal contents, calculated for soil horizons located at depths of 0-10 cm, 10-20 cm, 40-70 cm and over 70 cm (presented in Tables 4-4 to 4-8) are analyzed.

***The clear conclusion that may be drawn is that the overburden analyzed in the Roşia Montană area is not polluted with heavy metals.***

**Table 4-3. Statistical parameters of total heavy metal contents of the Roşia Montană area overburden**

Compared to the normal values (NV) and alert threshold (AT) and response threshold (IT) for a sensitive land use (MWFEP Order 756/1997)

| Statistic Parameter | Zn | Cu | Fe | Mn | Pb | Cd | Ni | Cr | Co |
|---|---|---|---|---|---|---|---|---|---|
| **n** | 153 | 153 | 153 | 153 | 153 | 153 | 153 | 153 | 153 |
| **x min** | 25.6 | 7.5 | 7.112 | 80 | 11.6 | 0.5 | 12.5 | 10.7 | 10.8 |
| **x max** | 271.9 | 39 | 47.138 | 2187 | 90 | 10.1 | 114 | 79.2 | 66.6 |
| | 87.5 | 17.8 | 28.794 | 645 | 35.7 | 1.24 | 49.3 | 29.9 | 29.9 |
| $\sigma$ | 34.9 | 5.4 | 8.094 | 340 | 13.9 | 1.08 | 24.7 | 14 | 11.6 |
| $x_g$ | 81.5 | 17.0 | | | 33.2 | 1.08 | 43.3 | 27.1 | 27.8 |
| **c.v. (%)** | 40 | 30 | 28 | 53 | 39 | 87 | 50 | 47 | 39 |
| **Me** | 82.5 | 16.7 | 28.910 | 573 | 35.0 | 1.00 | 44.2 | 26.3 | 26.6 |
| **Mo** | 81.7 | 15.9 | 30.016 | 519 | 33.4 | 1.11 | 39.0 | 22.1 | 26.1 |
| **Arch Coeff.** | 6 | 1.02 | -0.007 | 4.9 | 1.7 | 41 | -0.15 | 1.56 | 0.14 |
| **Asymmetry Coeff.** | 1.8 | 0.74 | -0.37 | 1.7 | 1 | 5.9 | 0.74 | 1.27 | 0.72 |
| **NV** | 100 | 20 | | 900 | 20 | 1 | 20 | 30 | 15 |
| **AT** | 300 | 100 | | 1500 | 50 | 3 | 75 | 100 | 30 |
| **IT** | 600 | 200 | | 2500 | 100 | 5 | 150 | 300 | 50 |

**Table 4-4. Statistical parameters of total heavy metal contents in horizon 0-10 cm of the Roşia Montană area overburden**

Compared to the normal values (NV) and alert threshold (AT) and response threshold (IT) for a sensitive land use (MWFEP Order 756/1997)

| Statistic Parameter | Zn | Cu | Fe | Mn | Pb | Cd | Ni | Cr | Co |
|---|---|---|---|---|---|---|---|---|---|
| **n** | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| **x min** | 49.6 | 11 | 13.807 | 359 | 18.5 | 0.65 | 12.5 | 10.7 | 12.8 |
| **x max** | 145.5 | 27.9 | 32.633 | 2.187 | 90 | 5.3 | 97.6 | 65 | 49.5 |
| | 92.0 | 17.9 | 24.877 | 741 | 44.1 | 1.37 | 44.4 | 29.5 | 28.9 |
| $\sigma$ | 26.8 | 4.6 | 5.450 | 407 | 17.1 | 0.98 | 23.8 | 14.3 | 9.6 |
| $x_g$ | 88.1 | 17.3 | 24.210 | 670 | 41.4 | 1.20 | 38.3 | 26.3 | 27.3 |
| **c.v. (%)** | 29 | 26 | 22 | 55 | 39 | 72 | 54 | 48 | 33 |
| **Me** | 97.5 | 17.2 | 26.307 | 671 | 39.3 | 1.1 | 40.2 | 28.5 | 29 |
| **Mo** | 95.62 | 15.13 | 26.574 | 568 | 40.5 | 1.14 | 28.2 | 16.9 | 30.1 |
| **Arch Coeff.** | -0.75 | -0.14 | -0.03 | 7.8 | 1.9 | 14 | -0.4 | 0.28 | -0.43 |
| **Asymmetry Coeff.** | 0.07 | 0.71 | 0.78 | 2.5 | 1.4 | 3.5 | 0.66 | 0.75 | 0.3 |
| **NV** | 100 | 20 | | 900 | 20 | 1 | 20 | 30 | 15 |
| **AT** | 300 | 100 | | 1500 | 50 | 3 | 75 | 100 | 30 |
| **IT** | 600 | 200 | | 2500 | 100 | 5 | 150 | 300 | 50 |

**Table 4-5. Statistical parameters of total heavy metal contents in horizon 10-20 cm of the Roşia Montană area overburden**

Compared to the normal values (NV) and alert threshold (AT) and response threshold (IT) for a sensitive land use (MWFEP Order 756/1997)

| Statistic Parameter | Zn | Cu | Fe | Mn | Pb | Cd | Ni | Cr | Co |
|---|---|---|---|---|---|---|---|---|---|
| **n** | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| **x min** | 56.2 | 8.1 | 7.880 | 264 | 11.6 | 0.65 | 18.8 | 14.1 | 16.8 |
| **x max** | 152.1 | 31.8 | 36.564 | 1.847 | 75 | 1.8 | 114 | 79.2 | 66.6 |
| | 91.3 | 18.1 | 27.389 | 762 | 30.6 | 1.07 | 52.9 | 34.1 | 37.6 |
| $\sigma$ | 24.7 | 5.1 | 7.604 | 413 | 14.1 | 0.29 | 27 | 18.5 | 13.5 |
| $x_g$ | 88.2 | 17.4 | 25.861 | 677 | 28.1 | 1.04 | 46.8 | 29.7 | 35.3 |
| **c.v. (%)** | 27 | 28 | 28 | 54 | 46 | 27 | 51 | 54 | 36.0 |
| **Me** | 91 | 16.6 | 29.116 | 649 | 25.4 | 1 | 48.4 | 31.4 | 35.9 |
| **Mo** | 96.9 | 15.5 | 28.765 | 471 | 29.6 | 1.36 | 34.8 | 23.1 | 26.6 |
| **Arch Coeff.** | 1 | 2.9 | 2.15 | 1.78 | 5.9 | 1.06 | -0.04 | 0.49 | -0.21 |
| **Asymmetry Coeff.** | 0.69 | 0.93 | -1.49 | 1.44 | 2 | 0.84 | 0.8 | 0.86 | 0.41 |
| **NV** | 100 | 20 | | 900 | 20 | 1 | 20 | 30 | 15 |
| **AT** | 300 | 100 | | 1500 | 50 | 3 | 75 | 100 | 30 |
| **IT** | 600 | 200 | | 2500 | 100 | 5 | 150 | 300 | 50 |

**Table 4-6. Statistical parameters of total heavy metal contents in horizon 20-40 cm of the Roşia Montană area overburden**

Compared to the normal values (NV) and alert threshold (AT) and response threshold (IT) for a sensitive land use (MWFEP Order 756/1997)

| Statistic Parameter | Zn | Cu | Fe | Mn | Pb | Cd | Ni | Cr | Co |
|---|---|---|---|---|---|---|---|---|---|
| **n** | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| **x min** | 32.2 | 8.3 | 12.367 | 80 | 18.5 | 0.50 | 15.7 | 15.2 | 10.8 |
| **x max** | 190.5 | 31.8 | 43.132 | 2.112 | 75.0 | 10.10 | 111.3 | 68.9 | 52.9 |
| | 82.9 | 17.2 | 28.574 | 600 | 34.2 | 1.32 | 46.9 | 29.8 | 28.3 |
| $\sigma$ | 28.4 | 5.5 | 7.943 | 370 | 13.3 | 1.58 | 24.5 | 11.5 | 9.7 |
| $x_g$ | 78.4 | 16.4 | 27.347 | 508 | 32.0 | 1.07 | 41.3 | 27.8 | 26.7 |
| **c.v. (%)** | 34 | 32 | 28 | 62 | 39 | 120 | 52 | 39 | 34 |
| **Me** | 82.1 | 16.1 | 28.496 | 548 | 30.0 | 1.10 | 40.2 | 27.4 | 25.6 |
| **Mo** | 79.1 | 14.7 | 52.385 | 462 | 24.9 | 1.29 | 28.9 | 25.9 | 27.8 |
| **Arch Coeff.** | 5.1 | 0.58 | -0.45 | 7.3 | 1.0 | 30.3 | -0.07 | 2.44 | -0.05 |
| **Asymmetry Coeff.** | 1.4 | 0.86 | -0.25 | 2.14 | 0.97 | 5.4 | 0.87 | 1.25 | 0.5 |
| **NV** | 100 | 20 | | 900 | 20 | 1 | 20 | 30 | 15 |
| **AT** | 300 | 100 | | 1500 | 50 | 3 | 75 | 100 | 30 |
| **IT** | 600 | 200 | | 2500 | 100 | 5 | 150 | 300 | 50 |

**Table 4-7. Statistical parameters of total heavy metal contents in horizon 40-70 cm of the Roşia Montană area overburden**

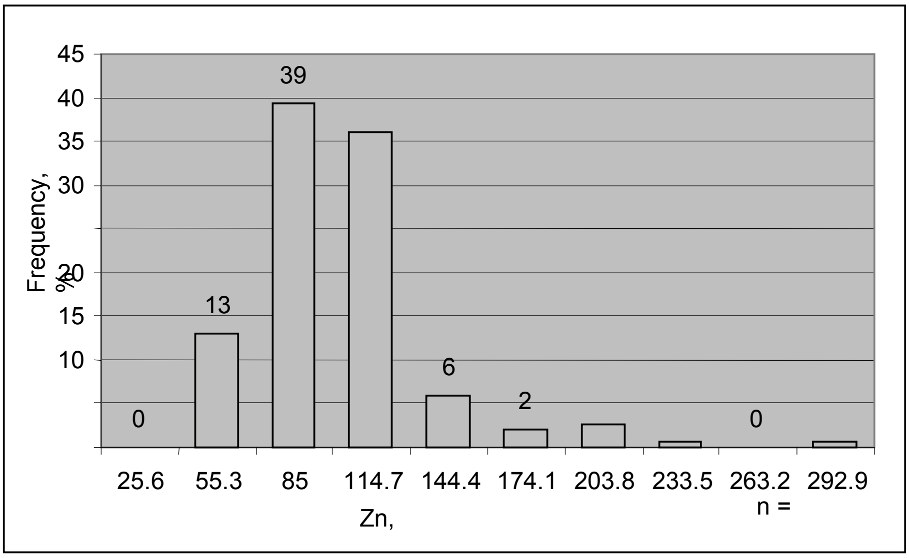
Compared to the normal values (NV) and alert threshold (AT) and response threshold (IT) for a sensitive land use (MWFEP Order 756/1997)

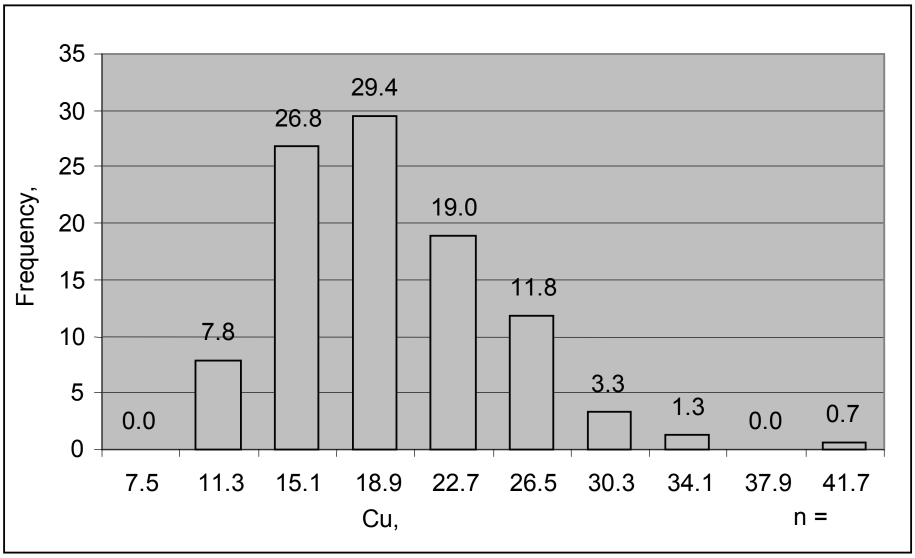
| Statistic Parameter | Zn | Cu | Fe | Mn | Pb | Cd | Ni | Cr | Co |
|---|---|---|---|---|---|---|---|---|---|
| **n** | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| **x min** | 25.6 | 7.5 | 7.112 | 124 | 11.6 | 0.50 | 18.8 | 15.2 | 10.8 |
| **x max** | 271.9 | 27.9 | 44.093 | 1.635 | 70.0 | 8.20 | 114.0 | 74.1 | 59.8 |
| | 88.8 | 17.3 | 29.971 | 646 | 33.3 | 1.34 | 58.3 | 33.5 | 31.9 |
| $\sigma$ | 46.5 | 5.2 | 8.931 | 302 | 13.2 | 1.26 | 28.3 | 17.0 | 12.4 |
| $x_g$ | 79.7 | 16.5 | 28.181 | 580 | 30.8 | 1.12 | 51.6 | 29.9 | 29.3 |
| **c.v. (%)** | 52 | 30 | 30 | 47 | 40 | 94 | 49 | 51 | 39 |
| **Me** | 81.3 | 17.3 | 31.861 | 567 | 32.3 | 1.10 | 50.6 | 26.9 | 30.7 |
| **Mo** | 80.9 | 18.3 | 33.555 | 493 | 33.9 | 1.12 | 36.3 | 21.3 | 24.3 |
| **Arch Coeff.** | 6.3 | -0.64 | 0.11 | 1.57 | 0.26 | 23.5 | -0.93 | 0.006 | -0.59 |
| **Asymmetry Coeff.** | 2.2 | 0.25 | -0.84 | 1.06 | 0.64 | 4.5 | 0.49 | 1.02 | 0.28 |
| **NV** | 100 | 20 | | 900 | 20 | 1 | 20 | 30 | 15 |
| **AT** | 300 | 100 | | 1500 | 50 | 3 | 75 | 100 | 30 |
| **IT** | 600 | 200 | | 2500 | 100 | 5 | 150 | 300 | 50 |

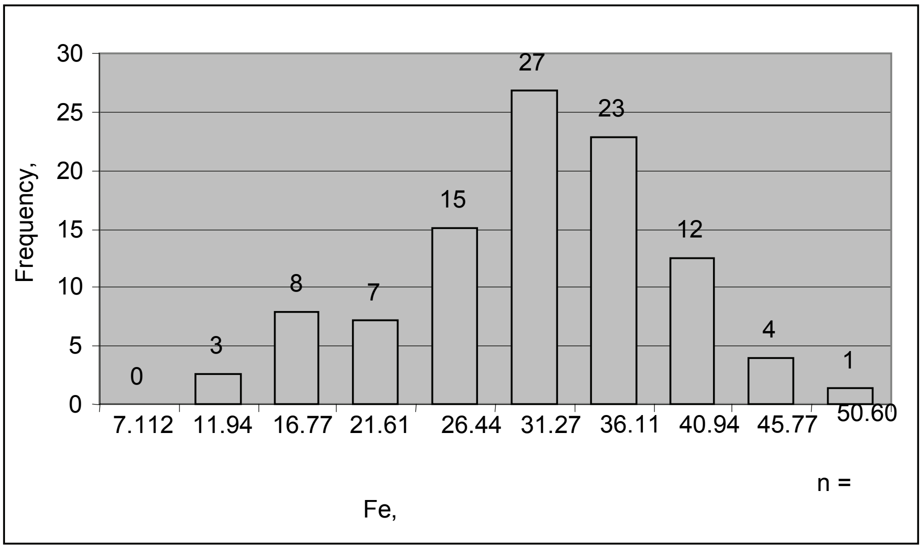
**Table 4-8. Statistical parameters of total heavy metal contents from a depth greater than 70 cm of the Roşia Montană area overburden**
Compared to the normal values (NV) and alert threshold (AT) and response threshold (IT) for a sensitive land use(MWFEP Order 756/1997)

| Statistic Parameter | Zn | Cu | Fe | Mn | Pb | Cd | Ni | Cr | Co |
|---|---|---|---|---|---|---|---|---|---|
| **n** | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| **x min** | 25.6 | 7.5 | 7.112 | 124 | 11.6 | 0.50 | 18.8 | 15.2 | 10.8 |
| **x max** | 271.9 | 27.9 | 44.093 | 1.635 | 70.0 | 8.20 | 114.0 | 74.1 | 59.8 |
| | 88.8 | 17.3 | 29.971 | 646 | 33.3 | 1.34 | 58.3 | 33.5 | 31.9 |
| $\sigma$ | 46.5 | 5.2 | 8.931 | 302 | 13.2 | 1.26 | 28.3 | 17.0 | 12.4 |
| $x_g$ | 79.7 | 16.5 | 28.181 | 580 | 30.8 | 1.12 | 51.6 | 29.9 | 29.3 |
| **c.v. (%)** | 52 | 30 | 30 | 47 | 40 | 94 | 49 | 51 | 39 |
| **Me** | 81.3 | 17.3 | 31.861 | 567 | 32.3 | 1.10 | 50.6 | 26.9 | 30.7 |
| **Mo** | 80.9 | 18.3 | 33.555 | 493 | 33.9 | 1.12 | 36.3 | 21.3 | 24.3 |
| **Arch Coeff.** | 6.3 | -0.64 | 0.11 | 1.57 | 0.26 | 23.5 | -0.93 | 0.006 | -0.59 |
| **Asymmetry Coeff.** | 2.2 | 0.25 | -0.84 | 1.06 | 0.64 | 4.5 | 0.49 | 1.02 | 0.28 |
| **NV** | 100 | 20 | | 900 | 20 | 1 | 20 | 30 | 15 |
| **AT** | 300 | 100 | | 1500 | 50 | 3 | 75 | 100 | 30 |
| **IT** | 600 | 200 | | 2500 | 100 | 5 | 150 | 300 | 50 |

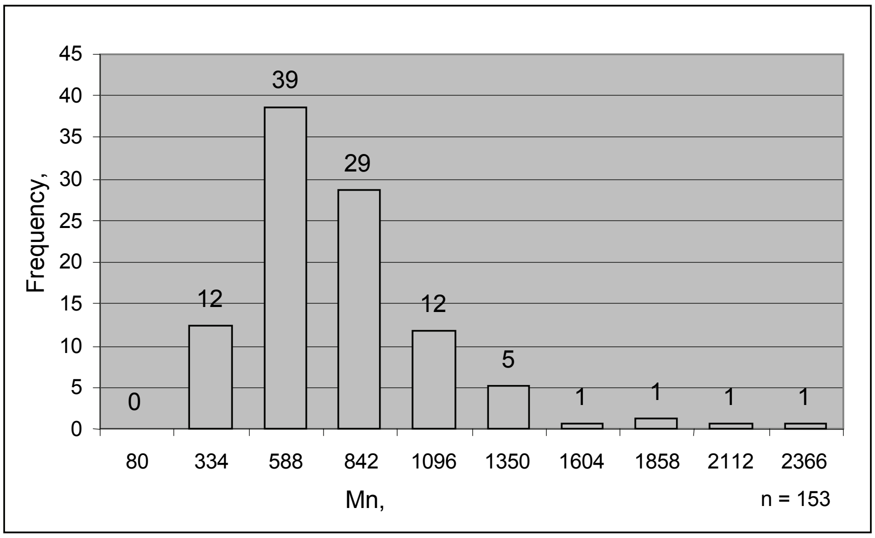
## Figure 4.5. Frequency of total Zn, Cu and Fe contents distribution in the Roşia Montană area overburden

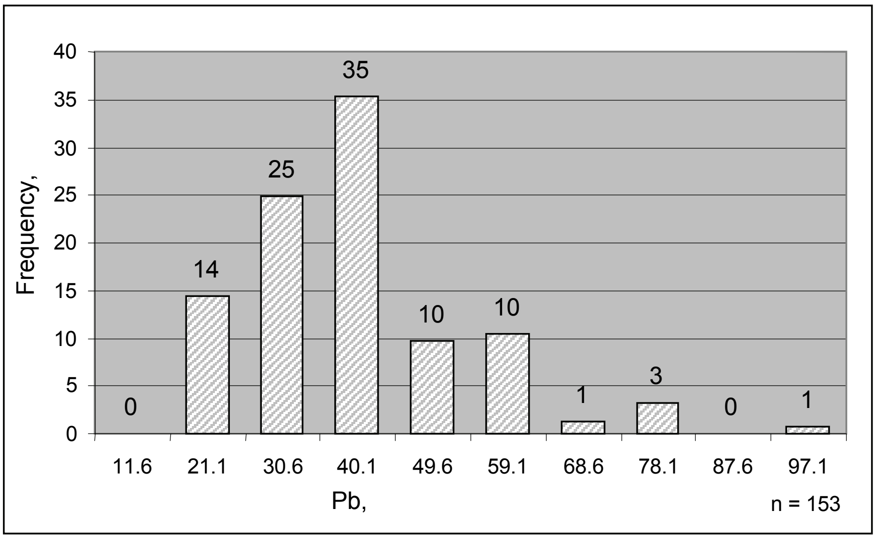


## Figure 4.6. Frequency of total Mn, Pb and Cd contents distribution in the Roşia Montană area overburden



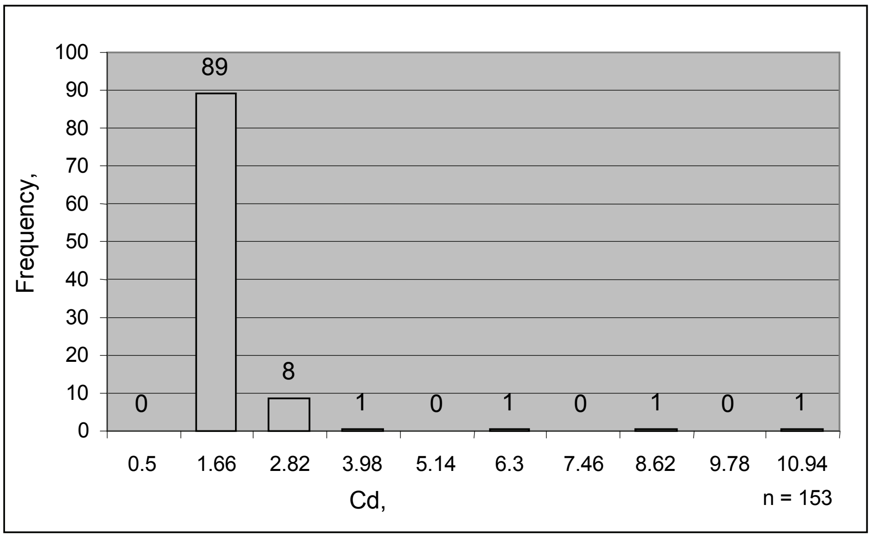
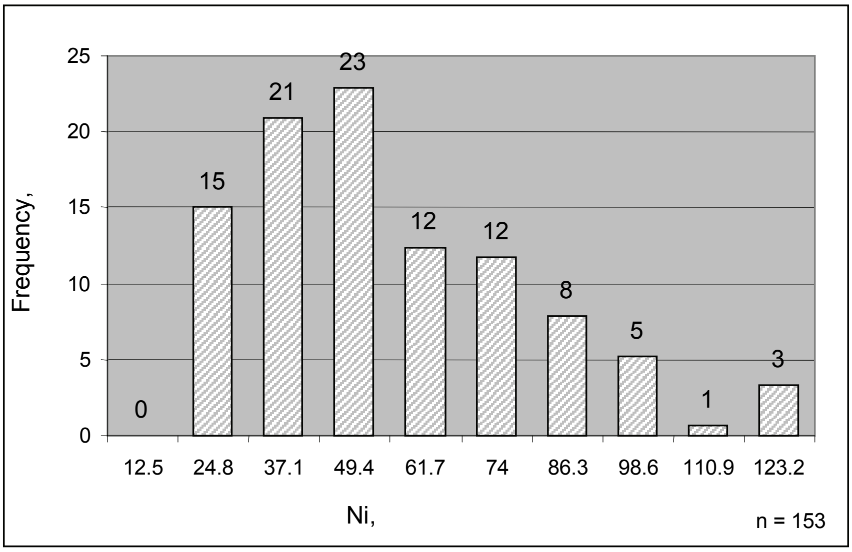
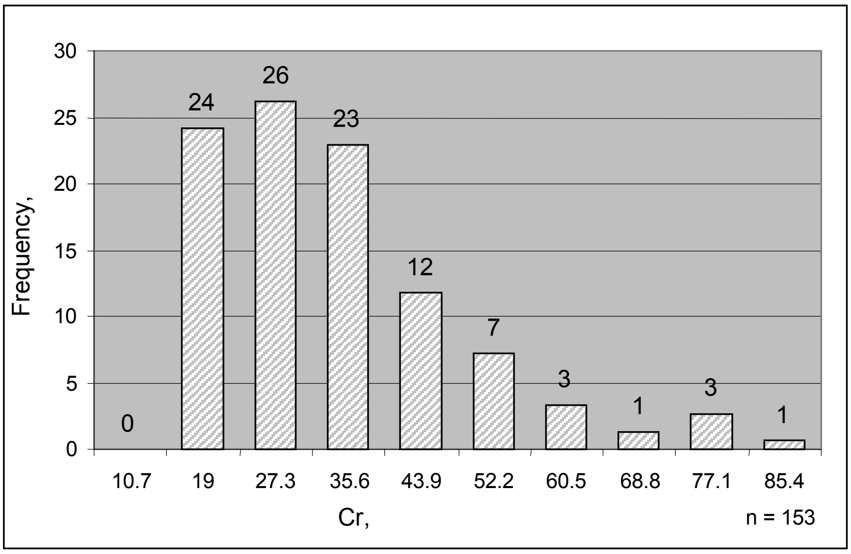
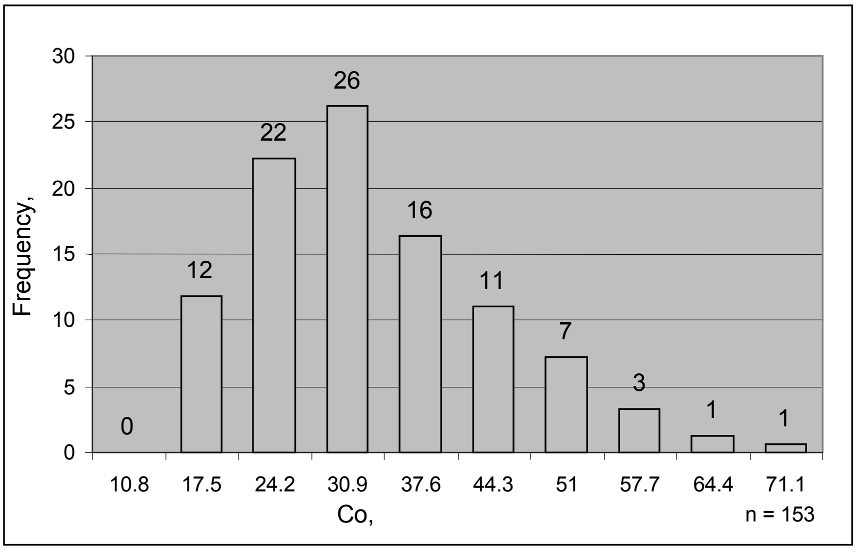



**Figure 4.7. Frequency of total Ni, Cr and Co contents distribution in the Roşia Montană area overburden**



## 4.6 Favorability of Soils to Various Crops

Estimation of the land production potential is a quantitative evaluation which is made by determining the quality grade of the farming lands. In assessing the quality grade, data regarding the soil properties and land characteristics are used, which are included in this pedological study and presented in the soil-land unit formulas, also called pedotops (seethe soil map legend). To conduct the quality grade assessment, the land units have been constituted as TEO units (ecologically homogenous territories), which represent basic areas (of soil-land), characterized by uniform soil-land and climatic-atmospheric conditions offered to cultivated plants. These TEO units (Table 4-9.) were characterized by way of the eco-pedologic indicators, which essentially are the soil, land and climate features parameterized and hierarchized as order of magnitude. Accordingly the eco-pedologic indicators are evaluated by way of the quality grade coefficients which in the end give quality grades for the considered crop. Where the TEO conditions are optimum for the physiological requirements of the considered crop(s), the coefficients have unit values (1.0). Where the TEO conditions are not optimum for the considered crops, the coefficients have subunit values (0.1….0.9). The yielded quality grades vary from 1 to 100 points and were grouped in 10 classes of favorability, each class having 10 points, as follows:

- **Class I:** 91-100 points;
- **Class II:** 81-90 points;
- **Class III:** 71-80 points;
- **Class IV:** 61-70 points;
- **Class V:** 51-60 points;
- **Class VI:** 41-50 points;
- **Class VII:** 31-40 points;
- **Class VIII:** 21-30 points;
- **Class IX:** 11-20 points;
- **Class X:** 1-10 points;

(see the land favorability map)

Given the land use traditional in the area (grazing land, apple and plum tree orchards) the quality grade assessment was conducted under natural conditions for the following crops: hay and grazing lands, apple and plum trees, potatoes. There were no wheat crops encountered in the area.
The value of the quality grades varies within certain limits for each of the above crops as the offered TEO conditions are closer or farther from the optimum level.
In this case, the conditions below the optimum level represent restrictive factors of the agricultural production for the considered crops. These restrictive factors are in fact indicators characterizing the TEO units, as follows:

- Average annual temperature (corrected values);
- Average annual precipitation (corrected values);
- Texture in horizon Ap (0-20 cm);
- Pollution degree;
- Land slope;
- Floodability;
- Total porosity;
- Soil reaction in Ap (0-20 cm);
- Useful edaphic volume;
- Humus reserve over 0-50 cm depth.

All these indicators are presented in Table 4-9.

## Table 4-9. TABLE - LEGEND With Quality Grade Eco-Pedologic Indicators

| INDICATORS (CODE) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. SU | No. TEO | Average Annual Temp. Corrected Values | Average Annual Precip. Corrected Values | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm Depth | Soil Edaphic Volume | Humus Reserve 0-50 cm; t/ha | Floodability by Overflow |
| | | (3C) | (4C) | (23) | (29) | (33) | (38) | (44) | (63) | (133) | (144) | (40) |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1 | 1/1 | 05.5 | 900 | 40 | | 12 | | +15 | 6.1 | 138 | 180 | |
| 2 | 2/1 | 05.5 | 900 | 40 | | 17 | 12 | -14 | 5.6 | 138 | 180 | |
| 3 | 3/1 | 05.5 | 1100 | 40 | | 12 | | -14 | 5.6 | 088 | 275 | |
| 4 | 4/1 | 05.5 | 900 | 40 | | 17 | | -10 | 6.1 | 138 | 180 | |
| | 4/2 | 06.5 | 900 | 40 | | 17 | | -10 | 6.1 | 138 | 180 | |
| 5 | 5/1 | 05.5 | 900 | 40 | | 17 | | -24 | 5.6 | 035 | 090 | |
| | 5/2 | 05.5 | 900 | 40 | | 17 | | -24 | 5.6 | 035 | 090 | |
| 6 | 6/1 | 05.5 | 1100 | 40 | | 12 | | +15 | 4.7 | 063 | 225 | |
| | 6/2 | 05.5 | 900 | 40 | | 17 | | +15 | 4.7 | 063 | 225 | |
| | 6/3 | 06.5 | 900 | 40 | | 22 | | +15 | 4.7 | 063 | 180 | |
| 7 | 7/1 | 05.5 | 1100 | 30 | | 03 | | +05 | 5.6 | 138 | 275 | |
| | 7/2 | 05.5 | 1100 | 30 | | 07 | | +05 | 5.6 | 138 | 275 | |
| | 7/3 | 05.5 | 1100 | 30 | | 12 | | +05 | 5.6 | 138 | 275 | |
| | 7/4 | 05.5 | 900 | 30 | | 17 | | +05 | 5.6 | 063 | 225 | |
| | 7/5 | 06.5 | 900 | 30 | | 22 | | +05 | 5.6 | 088 | 225 | |
| | 7/6 | 05.5 | 900 | 30 | | 22 | | +05 | 5.6 | 088 | 225 | |
| 8 | 8/1 | 06.5 | 900 | 40 | | 17 | | -05 | 4.7 | 113 | 225 | |
| | 8/2 | 05.5 | 900 | 40 | | 17 | | -05 | 4.7 | 113 | 225 | |
| 9 | 9/1 | 06.5 | 1100 | 40 | | 17 | | +15 | 6.1 | 063 | 090 | |
| 10 | 10/1 | 05.5 | 1100 | 30 | | 12 | | -24 | 5.2 | 035 | 180 | |
| | 10/2 | 05.5 | 1100 | 30 | | 12 | | -24 | 5.2 | 035 | 180 | |

| No. SU | No. TEO | Average Annual Temp. | Average Annual Precip. | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm | Soil Edaphic Volume | Humus Reserve 0-50 cm; | Floodability by Overflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Corrected Values | Corrected Values | | | | | | Depth | | t/ha | |
| | 10/3 | 05.5 | 900 | 30 | | 17 | | -24 | 5.2 | 035 | 180 | |
| | 10/4 | 05.5 | 900 | 30 | | 17 | | -24 | 5.2 | 035 | 180 | |
| | 10/5 | 05.5 | 900 | 30 | | 22 | | -24 | 5.2 | 035 | 180 | |
| 11 | 11/1 | 06.5 | 900 | 30 | | 30 | | -24 | 5.2 | 0.35 | 180 | |
| 12 | 12/1 | 05.5 | 1100 | 40 | | 12 | | -05 | 4.7 | 0.35 | 090 | |
| 13 | 13/1 | 05.5 | 900 | 30 | | 12 | 12 | +15 | 6.1 | 138 | 225 | |
| 14 | 14/1 | 05.5 | 900 | 40 | | 17 | | -14 | 5.6 | 138 | 140 | |
| 15 | 15/1 | 05.5 | 900 | 40 | | 12 | | +15 | 6.1 | 138 | 180 | |
| | | 05.5 | 1100 | 40 | | 12 | | -24 | 5.6 | 035 | 180 | |
| | 15/2 | 06.5 | 900 | 40 | | 17 | | +15 | 5.6 | 138 | 140 | |
| | | 06.5 | 900 | 40 | | 17 | | -24 | 5.6 | 035 | 140 | |
| | 15/3 | 06.5 | 750 | 40 | | 22 | | +15 | 6.1 | 138 | 180 | |
| | | 06.5 | 900 | 40 | | 22 | | -24 | 5.6 | 035 | 180 | |
| | 15/4 | 05.5 | 750 | 40 | | 22 | | +15 | 6.1 | 138 | 090 | |
| | | 05.5 | 900 | 40 | | 22 | | -24 | 5.6 | 035 | 090 | |
| 16 | 16/1 | 06.5 | 900 | 40 | | 17 | | +15 | 6.1 | 063 | 225 | |
| | | 06.5 | 900 | 40 | | 17 | | +05 | 6.1 | 035 | 180 | |
| | 16/2 | 06.5 | 900 | 40 | | 22 | | +15 | 6.1 | 063 | 225 | |
| | | 06.5 | 900 | 40 | | 22 | | +05 | 6.1 | 035 | 180 | |
| | 16/3 | 04.5 | 750 | 40 | | 30 | | -15 | 5.6 | 063 | 225 | |
| | | 04.5 | 750 | 30 | | 30 | | -15 | 5.6 | 035 | 140 | |
| | 16/4 | 04.5 | 750 | 40 | | 30 | | -15 | 5.6 | 063 | 225 | |
| | | 04.5 | 750 | 30 | | 30 | | -15 | 5.6 | 035 | 140 | |
| | 16/5 | 06.5 | 750 | 40 | | 30 | | -15 | 5.6 | 063 | 225 | |
| | | 06.5 | 750 | 30 | | 30 | | -15 | 5.6 | 035 | 140 | |
| | 16/6 | 06.5 | 750 | 40 | | 30 | | -15 | 5.6 | 063 | 225 | |

| No. SU | No. TEO | Average Annual Temp. Corrected Values | Average Annual Precip. Corrected Values | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm Depth | Soil Edaphic Volume | Humus Reserve 0-50 cm; t/ha | Floodability by Overflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 06.5 | 750 | 30 | | 30 | | -15 | 5.6 | 035 | 140 | |
| 17 | 17/1 | 05.5 | 900 | 40 | | 17 | | +15 | 6.1 | 063 | 180 | |
| | | 05.5 | 900 | 40 | | 17 | | +15 | 6.1 | 035 | 140 | |
| | 17/2 | 06.5 | 900 | 40 | | 30 | | +15 | 6.1 | 063 | 180 | |
| | | 06.5 | 900 | 40 | | 30 | | +15 | 6.1 | 035 | 140 | |
| 18 | 18/1 | 05.5 | 900 | 30 | | 17 | | +15 | 6.6 | 088 | 180 | |
| | | 05.5 | 900 | 30 | | 17 | | +15 | 6.6 | 063 | 045 | |
| | 18/2 | 05.5 | 900 | 30 | | 22 | | +15 | 6.6 | 088 | 180 | |
| | | 05.5 | 900 | 30 | | 22 | | +15 | 6.6 | 063 | 045 | |
| | 18/3 | 06.5 | 750 | 30 | | 30 | | +15 | 6.6 | 088 | 180 | |
| | | 06.5 | 750 | 30 | | 30 | | +15 | 6.6 | 063 | 045 | |
| | 18/4 | 05.5 | 750 | 30 | | 42 | | +15 | 6.6 | 063 | 140 | |
| | | 05.5 | 750 | 30 | | 42 | | +15 | 6.6 | 035 | 045 | |
| | 18/5 | 06.5 | 750 | 30 | | 42 | | +15 | 6.6 | 063 | 140 | |
| | | 06.5 | 750 | 30 | | 42 | | +15 | 6.6 | 035 | 045 | |
| 19 | 19/1 | 05.5 | 1100 | 50 | | 12 | | +15 | 5.2 | 063 | 225 | |
| | | 05.5 | 1100 | 50 | | 12 | | -05 | 5.2 | 035 | 180 | |
| 20 | 20/1 | 05.5 | 900 | 30 | | 03 | | -05 | 7.5 | 035 | 180 | |
| | | 05.5 | 900 | 30 | | 03 | | -05 | 7.5 | 015 | 045 | |
| 21 | 21/1 | 06.5 | 750 | 40 | | 30 | | -05 | 7.5 | 035 | 140 | |
| | | 06.5 | 750 | 40 | | 30 | | -05 | 7.5 | 015 | 045 | |
| | 21/2 | 06.5 | 750 | 40 | | 30 | | -15 | 7.5 | 035 | 140 | |
| | | 06.5 | 750 | 40 | | 30 | | -05 | 7.5 | 015 | 045 | |
| 22 | 22/1 | 05.5 | 1100 | 40 | | 07 | | -05 | 6.1 | 035 | 180 | 2 |
| | | 05.5 | 1100 | 40 | | 07 | | -05 | 6.1 | 015 | 045 | 2 |
| | 22/2 | 05.5 | 900 | 40 | | 17 | | -15 | 6.1 | 035 | 180 | 2 |

| No. SU | No. TEO | Average Annual Temp. | Average Annual Precip. | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm | Soil Edaphic Volume | Humus Reserve 0-50 cm; | Floodability by Overflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Corrected Values | Corrected Values | | | | | | Depth | | t/ha | |
| | | 05.5 | 900 | 40 | | 17 | | -05 | 6.1 | 015 | 045 | 2 |
| 23 | 23/1 | 05.5 | 900 | 40 | | 17 | | -15 | 6.1 | 015 | 045 | |
| | | 05.5 | 900 | 40 | | 17 | | -15 | 6.1 | 005 | 015 | |
| | 23/2 | 06.5 | 750 | 40 | | 42 | | -14 | 6.1 | 015 | 045 | |
| | | 06.5 | 750 | 40 | | 42 | | -24 | 6.1 | 005 | 015 | |
| 24 | 24/1 | 05.5 | 750 | 40 | | 42 | | -24 | 5.6 | 035 | 045 | |
| | | 05.5 | 750 | 40 | | 42 | | -24 | 5.6 | 035 | 045 | |
| 25 | 25/1 | 05.5 | 900 | 30 | | 17 | | -14 | 4.7 | 138 | 140 | |
| | | 05.5 | 900 | 30 | | 17 | | -24 | 4.7 | 035 | 140 | |
| 26 | 26/1 | 06.5 | 900 | 40 | | 17 | | +15 | 4.7 | 063 | 180 | |
| | | 06.5 | 900 | 40 | | 17 | | -24 | 4.7 | 035 | 180 | |
| | 26/2 | 06.5 | 900 | 40 | | 22 | | +15 | 4.7 | 063 | 180 | |
| | | 06.5 | 900 | 40 | | 22 | | -24 | 4.7 | 035 | 180 | |
| | 26/3 | 05.5 | 900 | 40 | | 17 | | +15 | 6.1 | 138 | 180 | |
| | | 05.5 | 900 | 40 | | 17 | | +15 | 6.1 | 035 | 045 | |
| | 26/4 | 05.5 | 900 | 40 | | 22 | | +15 | 6.1 | 138 | 180 | |
| | | 05.5 | 900 | 40 | | 22 | | +15 | 6.1 | 035 | 045 | |
| | 26/5 | 04.5 | 750 | 40 | | 30 | | -15 | 5.2 | 063 | 180 | |
| | | 04.5 | 750 | 30 | | 30 | | -15 | 5.2 | 035 | 140 | |
| | 26/6 | 04.5 | 750 | 40 | | 30 | | -15 | 5.2 | 063 | 180 | |
| | | 04.5 | 750 | 30 | | 30 | | -15 | 5.2 | 035 | 140 | |
| | 26/7 | 06.5 | 750 | 40 | | 30 | | -15 | 5.2 | 063 | 180 | |
| | | 06.5 | 750 | 30 | | 30 | | -15 | 5.2 | 035 | 140 | |
| 27 | 27/1 | 06.5 | 900 | 40 | | 30 | | +05 | 5.2 | 063 | 140 | |
| | | 06.5 | 900 | 40 | | 30 | | -24 | 5.2 | 035 | 140 | |
| 28 | 28/1 | 05.5 | 900 | 30 | | 17 | | +05 | 5.2 | 063 | 180 | |

| No. SU | No. TEO | Average Annual Temp. | Average Annual Precip. | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm | Soil Edaphic Volume | Humus Reserve 0-50 cm; | Floodability by Overflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Corrected Values | Corrected Values | | | | | | Depth | | t/ha | |
| | | 05.5 | 900 | 30 | | 17 | | +05 | 5.2 | 138 | 225 | |
| | 28/2 | 05.5 | 900 | 30 | | 17 | | +05 | 5.2 | 063 | 180 | |
| | | 05.5 | 900 | 30 | | 17 | | +05 | 5.2 | 138 | 225 | |
| 29 | 29/1 | 06.5 | 900 | 30 | | 17 | | +05 | 4.7 | 063 | 140 | |
| | | 06.5 | 900 | 30 | | 17 | | -14 | 4.7 | 005 | 090 | |
| 30 | 30/1 | 05.5 | 900 | 30 | | 17 | | +05 | 5.2 | 063 | 180 | |
| | | 05.5 | 900 | 30 | | 17 | | +05 | 5.2 | 015 | 045 | |
| | 30/2 | 05.5 | 750 | 30 | | 30 | | +05 | 5.2 | 063 | 140 | |
| | | 05.5 | 750 | 30 | | 30 | | +05 | 5.2 | 005 | 045 | |
| | 30/3 | 05.5 | 750 | 30 | | 42 | | +05 | 5.2 | 063 | 180 | |
| | | 05.5 | 750 | 30 | | 42 | | -14 | 5.2 | 005 | 045 | |
| | 30/4 | 06.5 | 750 | 30 | | 42 | | +05 | 5.2 | 063 | 180 | |
| | | 06.5 | 750 | 30 | | 42 | | -14 | 5.2 | 005 | 045 | |
| | 30/5 | 06.5 | 750 | 30 | | 42 | | +05 | 5.2 | 063 | 180 | |
| | | 06.5 | 750 | 30 | | 42 | | -14 | 5.2 | 005 | 045 | |
| | 30/6 | 06.5 | 650 | 30 | | 75 | | +05 | 5.2 | 063 | 090 | |
| | | 06.5 | 650 | 30 | | 75 | | -14 | 5.2 | 005 | 045 | |
| 31 | 31/1 | 05.5 | 900 | 30 | | 17 | | +15 | 4.7 | 088 | 180 | |
| | | 05.5 | 900 | 30 | | 17 | | +05 | 4.7 | 035 | 090 | |
| | 31/2 | 05.5 | 900 | 30 | | 22 | | +15 | 4.7 | 088 | 180 | |
| | | 05.5 | 900 | 30 | | 22 | | +05 | 4.7 | 035 | 090 | |
| | 31/3 | 06.5 | 900 | 30 | | 22 | | +15 | 4.7 | 088 | 180 | |
| | | 06.5 | 900 | 30 | | 22 | | +05 | 4.7 | 035 | 090 | |
| | 31/4 | 05.5 | 900 | 30 | | 22 | | +15 | 4.7 | 088 | 180 | |
| | | 05.5 | 900 | 30 | | 22 | | +05 | 4.7 | 035 | 090 | |
| | 31/5 | 06.5 | 900 | 30 | | 30 | | +15 | 4.7 | 088 | 180 | |

| No. SU | No. TEO | Average Annual Temp. Corrected Values | Average Annual Precip. Corrected Values | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm Depth | Soil Edaphic Volume | Humus Reserve 0-50 cm; t/ha | Floodability by Overflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 06.5 | 900 | 30 | | 30 | | +05 | 4.7 | 035 | 090 | |
| | 31/6 | 04.5 | 750 | 30 | | 42 | | +15 | 4.7 | 088 | 180 | |
| | | 04.5 | 750 | 30 | | 42 | | +05 | 4.7 | 080 | 090 | |
| 32 | 32/1 | 04.5 | 900 | 40 | | 22 | | -15 | 5.2 | 063 | 180 | |
| | | 04.5 | 900 | 30 | | 22 | | -15 | 5.2 | 035 | 140 | |
| | 32/2 | 05.5 | 900 | 40 | | 22 | | -15 | 5.2 | 063 | 180 | |
| | | 05.5 | 900 | 30 | | 22 | | -15 | 5.2 | 035 | 140 | |
| | 32/3 | 06.5 | 900 | 40 | | 22 | | -15 | 5.2 | 063 | 180 | |
| | | 06.5 | 900 | 30 | | 22 | | -15 | 5.2 | 035 | 140 | |
| | 32/4 | 05.5 | 900 | 40 | | 22 | | -15 | 5.2 | 063 | 180 | |
| | | 05.5 | 900 | 30 | | 22 | | -15 | 5.2 | 035 | 140 | |
| 33 | 33/1 | 04.5 | 900 | 40 | | 22 | | -25 | 5.2 | 063 | 180 | |
| | | 04.5 | 900 | 40 | | 22 | | -25 | 5.2 | 035 | 225 | |
| | 33/2 | 06.5 | 900 | 40 | | 22 | | -25 | 5.2 | 063 | 180 | |
| | | 06.5 | 900 | 40 | | 22 | | -25 | 5.2 | 035 | 225 | |
| | 33/3 | 05.5 | 900 | 40 | | 22 | | -25 | 5.2 | 063 | 180 | |
| | | 05.5 | 900 | 40 | | 22 | | -25 | 5.2 | 035 | 225 | |
| 34 | 34/1 | 05.5 | 900 | 40 | | 22 | | +15 | 4.7 | 063 | 275 | |
| | | 05.5 | 900 | 40 | | 22 | | +15 | 4.7 | 035 | 045 | |
| 35 | 35/1 | 04.5 | 750 | 30 | | 42 | | -25 | 5.6 | 035 | 090 | |
| | | 04.5 | 750 | 30 | | 42 | | -25 | 5.6 | 015 | 045 | |
| 36 | 36/1 | 05.5 | 1100 | 40 | | 12 | | -24 | 5.2 | 035 | 090 | |
| | | 05.5 | 1100 | 40 | | 12 | | -24 | 5.2 | 015 | 090 | |
| | 36/2 | 05.5 | 900 | 40 | | 17 | | -24 | 5.2 | 035 | 090 | |
| | | 05.5 | 900 | 40 | | 17 | | -24 | 5.2 | 015 | 090 | |
| | 36/3 | 04.5 | 900 | 40 | | 22 | | -24 | 5.2 | 035 | 090 | |

| No. SU | No. TEO | Average Annual Temp. | Average Annual Precip. | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm | Soil Edaphic Volume | Humus Reserve 0-50 cm; | Floodability by Overflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Corrected Values | Corrected Values | | | | | | Depth | | t/ha | |
| | | 04.5 | 900 | 40 | | 22 | | -24 | 5.2 | 015 | 090 | |
| | 36/4 | 05.5 | 900 | 40 | | 22 | | -24 | 5.2 | 035 | 090 | |
| | | 05.5 | 900 | 40 | | 22 | | -24 | 5.2 | 015 | 090 | |
| | 36/5 | 04.5 | 900 | 40 | | 30 | | -24 | 5.2 | 035 | 090 | |
| | | 04.5 | 900 | 40 | | 30 | | -24 | 5.2 | 015 | 090 | |
| | 36/6 | 06.5 | 900 | 40 | | 30 | | -24 | 5.2 | 035 | 090 | |
| | | 06.5 | 900 | 40 | | 30 | | -24 | 5.2 | 015 | 090 | |
| | 36/7 | 0.45 | 750 | 40 | | 42 | | -24 | 5.2 | 035 | 045 | |
| | | 0.45 | 750 | 40 | | 42 | | -24 | 5.2 | 015 | 045 | |
| | 36/8 | 06.5 | 750 | 40 | | 42 | | -24 | 5.2 | 035 | 090 | |
| | | 06.5 | 750 | 40 | | 42 | | -24 | 5.2 | 015 | 090 | |
| 37 | 37/1 | 04.5 | 750 | 40 | | 42 | | -24 | 4.7 | 035 | 090 | |
| | | 04.5 | 750 | 40 | | 42 | | -24 | 4.7 | 015 | 090 | |
| | 37/2 | 04.5 | 525 | 30 | | 75 | | -24 | 5.6 | 035 | 090 | |
| | | 04.5 | 525 | 30 | | 75 | | -24 | 5.6 | 015 | 045 | |
| | 37/3 | 07.5 | 650 | 40 | | 75 | | -24 | 4.7 | 035 | 015 | |
| | | 07.5 | 650 | 40 | | 75 | | -24 | 4.7 | 005 | 015 | |
| | 37/4 | 06.5 | 650 | 40 | | 75 | | -24 | 4.7 | 035 | 015 | |
| | | 06.5 | 650 | 40 | | 75 | | -24 | 4.7 | 005 | 015 | |
| 38 | 38/1 | 06.5 | 900 | 40 | | 17 | | -05 | 4.7 | 088 | 180 | |
| | | 06.5 | 900 | 40 | | 17 | | -05 | 4.7 | 015 | 015 | |
| | 38/2 | 05.5 | 900 | 40 | | 22 | | -05 | 4.7 | 088 | 180 | |
| | | 05.5 | 900 | 40 | | 22 | | -05 | 4.7 | 015 | 015 | |
| 39 | 39/1 | 06.5 | 900 | 40 | | 22 | | -14 | 4.7 | 035 | 090 | |
| | | 06.5 | 900 | 40 | | 22 | | -05 | 4.7 | 035 | 090 | |
| 40 | 40/1 | 04.5 | 650 | 30 | | 30 | | -25 | 5.2 | 035 | 090 | |

| No. SU | No. TEO | Average Annual Temp. | Average Annual Precip. | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm | Soil Edaphic Volume | Humus Reserve 0-50 cm; | Floodability by Overflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Corrected Values | Corrected Values | | | | | | Depth | | t/ha | |
| | | 04.5 | 650 | 30 | | 30 | | -25 | 5.2 | 015 | 045 | |
| 41 | 41/1 | 06.5 | 900 | 30 | | 30 | | -14 | 4.7 | 015 | 090 | |
| | | 06.5 | 750 | 30 | | 30 | | -24 | 4.7 | 005 | 045 | |
| | 41/2 | 06.5 | 900 | 30 | | 42 | | -14 | 4.7 | 015 | 045 | |
| | | 06.5 | 750 | 30 | | 42 | | -24 | 4.7 | 005 | 015 | |
| 42 | 42/1 | 05.5 | 900 | 30 | | 17 | | -24 | 4.7 | 035 | 090 | |
| | | 05.5 | 900 | 30 | | 17 | | -24 | 4.7 | 015 | 090 | |
| | 42/2 | 05.5 | 750 | 30 | | 42 | | -24 | 4.7 | 035 | 090 | |
| | | 05.5 | 750 | 30 | | 42 | | -24 | 4.7 | 015 | 090 | |
| | 42/3 | 06.5 | 750 | 30 | | 42 | | -24 | 4.7 | 035 | 090 | |
| | | 06.5 | 750 | 30 | | 42 | | -24 | 4.7 | 015 | 090 | |
| | 42/4 | 06.5 | 750 | 30 | | 42 | | -24 | 4.7 | 035 | 090 | |
| | | 06.5 | 750 | 30 | | 42 | | -24 | 4.7 | 015 | 090 | |
| 43 | 43/1 | 05.5 | 750 | 30 | | 42 | | -24 | 5.2 | 035 | 045 | |
| | | 05.5 | 750 | 30 | | 42 | | -24 | 5.2 | 015 | 045 | |
| 44 | 44/1 | 04.5 | 525 | 30 | | 42 | | -15 | 6.1 | 035 | 045 | |
| | | 04.5 | 525 | 30 | | 42 | | -15 | 6.1 | 015 | 015 | |
| 45 | 45/1 | 06.5 | 750 | 30 | | 42 | | -24 | 5.2 | 005 | 015 | |
| | | 06.5 | 750 | 30 | | 42 | | -24 | 5.2 | 005 | 015 | |
| | 45/2 | 07.5 | 650 | 30 | | 75 | | -15 | 6.1 | 035 | 045 | |
| | | 07.5 | 650 | 30 | | 75 | | -15 | 6.1 | 015 | 015 | |
| | 45/3 | 06.5 | 650 | 30 | | 75 | | -24 | 5.2 | 005 | 015 | |
| | | 06.5 | 650 | 30 | | 75 | | -24 | 5.2 | 005 | 015 | |
| | 45/4 | 06.5 | 650 | 30 | | 75 | | -24 | 5.2 | 005 | 015 | |
| | | 06.5 | 650 | 30 | | 75 | | -24 | 5.2 | 005 | 015 | |
| 46 | 46/1 | 05.5 | 1100 | 30 | | 12 | | -24 | 4.7 | 015 | 015 | |

| No. SU | No. TEO | Average Annual Temp. Corrected Values | Average Annual Precip. Corrected Values | Texture in horizon A | Pollution Degree | Land Slope | Landslides | Total Porosity | Soil Reaction 0-20 cm Depth | Soil Edaphic Volume | Humus Reserve 0-50 cm; t/ha | Floodability by Overflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 05.5 | 1100 | 30 | | 12 | | -24 | 4.7 | 005 | 015 | |
| | 46/2 | 05.5 | 900 | 30 | | 17 | | -24 | 4.7 | 015 | 015 | |
| | | 05.5 | 900 | 30 | | 17 | | -24 | 4.7 | 005 | 015 | |
| | 46/3 | 06.5 | 900 | 30 | 38 | 30 | | -24 | 6.6 | 005 | 045 | |
| | 46/4 | 05.5 | 900 | 30 | 38 | 30 | | -24 | 4.7 | 005 | 015 | |
| | 46/5 | 06.5 | 750 | 30 | 38 | 42 | | -24 | 6.6 | 005 | 045 | |

## Table 4-10. Quality Grades on TEO and Crops1 for Roşia Montană Area

| TEO No. | Area (ha) | PS* | FN | MR | PN | CT | TEO No. | Area (ha) | PS* | FN | MR | PN | CT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 1/1 | 18.8 | 81 | 73 | 33 | 19 | 4 | 16/4 | 4.9 | 61 | 43 | 11 | 5 | 5 |
| 2/1 | 8.5 | 53 | 47 | 18 | 10 | 12 | 16/5 | 16.9 | 67 | 52 | 22 | 22 | 7 |
| 3/1 | 4.8 | 66 | 53 | 29 | 11 | 29 | 16/6 | 4.9 | 67 | 54 | 22 | 22 | 5 |
| 4/1 | 5.1 | 81 | 72 | 36 | 19 | 28 | 17/1 | 10.2 | 81 | 72 | 29 | 17 | 24 |
| 4/2 | 15.4 | 90 | 80 | 43 | 31 | 36 | 17/2 | 23.1 | 70 | 60 | 18 | 16 | 5 |
| 5/1 | 2.4 | 59 | 53 | 20 | 11 | 16 | 18/1 | 14.5 | 67 | 57 | 28 | 13 | 22 |
| 5/2 | 3.2 | 59 | 48 | 20 | 11 | 15 | 18/2 | 7.1 | 60 | 50 | 22 | 12 | 9 |
| 6/1 | 7.4 | 65 | 52 | 21 | 6 | 22 | 18/3 | 14.8 | 58 | 48 | 23 | 17 | 6 |
| 6/2 | 49.9 | 72 | 64 | 25 | 13 | 23 | 18/4 | 26.3 | 47 | 45 | 10 | 5 | 5 |
| 7/1 | 35.3 | 66 | 58 | 32 | 10 | 44 | 18/5 | 1.6 | 52 | 50 | 13 | 9 | 6 |
| 7/2 | 17.2 | 66 | 58 | 32 | 10 | 44 | 19/1 | 21.1 | 78 | 62 | 28 | 10 | 25 |
| 7/3 | 47.1 | 66 | 58 | 32 | 10 | 44 | 20/1 | 2.7 | 69 | 67 | 19 | 12 | 27 |
| 7/4 | 10.0 | 66 | 58 | 32 | 11 | 23 | 21/1 | 33.8 | 62 | 51 | 14 | 13 | 5 |
| 7/5 | 9.0 | 65 | 57 | 31 | 18 | 13 | 21/2 | 36.1 | 56 | 46 | 9 | 9 | 5 |
| 7/6 | 13.0 | 66 | 58 | 29 | 12 | 25 | 22/1 | 25.5 | 63 | 53 | 12 | 5 | 24 |
| 7/7 | 5.8 | 65 | 57 | 30 | 17 | 12 | 22/2 | 5.6 | 56 | 48 | 9 | 6 | 10 |
| 8/1 | 0.9 | 72 | 64 | 35 | 19 | 29 | 23/1 | 24.8 | 48 | 38 | 7 | 5 | 10 |
| 8/2 | 2.9 | 65 | 58 | 29 | 11 | 22 | 23/2 | 38.1 | 26 | 23 | 3 | 2 | 2 |
| 9/1 | 32.1 | 59 | 42 | 16 | 6 | 17 | 24/1 | 14.7 | 32 | 29 | 6 | 3 | 3 |
| 10/1 | 5.2 | 47 | 38 | 18 | 6 | 23 | 25/1 | 1.3 | 51 | 46 | 21 | 8 | 2 |
| 10/2 | 6.4 | 47 | 38 | 19 | 6 | 23 | 26/1 | 5.8 | 66 | 59 | 23 | 13 | 21 |
| 10/3 | 1.8 | 47 | 42 | 18 | 7 | 19 | 26/2 | 27.4 | 78 | 66 | 26 | 16 | 21 |
| 10/4 | 4.9 | 47 | 42 | 18 | 9 | 19 | 26/3 | 6.4 | 59 | 52 | 20 | 12 | 8 |
| 10/5 | 1.1 | 42 | 37 | 16 | 6 | 7 | 26/4 | 2.1 | 66 | 50 | 23 | 14 | 8 |
| 11/1 | 6.7 | 40 | 35 | 15 | 8 | 5 | 26/5 | 120.7 | 50 | 35 | 10 | 3 | 4 |
| 12/1 | 11.4 | 58 | 41 | 18 | 6 | 17 | 26/6 | 6.9 | 46 | 35 | 10 | 4 | 5 |
| 13/1 | 4.9 | 59 | 52 | 18 | 11 | 16 | 26/7 | 105.9 | 54 | 44 | 20 | 16 | 7 |
| 14/1 | 8.0 | 73 | 59 | 32 | 17 | 29 | 27/1 | 7.1 | 52 | 40 | 17 | 11 | 5 |
| 15/1 | 21.2 | 69 | 60 | 29 | 24 | 38 | 28/1 | 4.7 | 65 | 58 | 28 | 12 | 25 |
| 15/2 | 12.4 | 78 | 63 | 32 | 25 | 25 | 28/2 | 5.7 | 58 | 52 | 25 | 12 | 25 |
| 15/3 | 21.0 | 69 | 61 | 32 | 23 | 12 | 29/1 | 8.2 | 42 | 39 | 16 | 8 | 15 |
| 15/4 | 9.7 | 56 | 44 | 22 | 14 | 7 | 30/1 | 1.1 | 50 | 43 | 17 | 9 | 18 |
| 16/1 | 28.6 | 86 | 77 | 29 | 23 | 27 | 30/2 | 4.4 | 39 | 32 | 12 | 7 | 4 |
| 16/2 | 15.9 | 77 | 67 | 23 | 19 | 12 | 30/3 | 50.4 | 33 | 32 | 7 | 3 | 4 |
| 16/3 | 50.8 | 61 | 43 | 11 | 5 | 5 | 30/4 | 8.8 | 37 | 35 | 8 | 6 | 5 |
| 30/5 | 7.9 | 37 | 35 | 8 | 6 | 5 | 37/1 | 22.4 | 25 | 19 | 4 | 6 | 3 |
| 30/6 | 2.8 | 25 | 18 | 6 | 4 | 5 | 37/2 | 18.5 | 20 | 9 | 2 | 6 | 3 |
| 31/1 | 24.7 | 56 | 48 | 20 | 8 | 17 | 37/3 | 2.2 | 16 | 9 | 11 | 3 | 2 |
| 31/2 | 37.8 | 50 | 41 | 17 | 7 | 7 | 37/4 | 12.4 | 15 | 9 | 8 | 6 | 5 |

[1] *PS – grazing land; FN – hay land; MR - apple; PN - plum; CT - potato

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31/3 | 11.5 | 56 | 46 | 20 | 11 | 8 | 38/1 | 19.6 | 64 | 55 | 25 | 14 | 22 |
| 31/4 | 8.7 | 53 | 41 | 17 | 7 | 7 | 38/2 | 25.9 | 51 | 43 | 18 | 8 | 7 |
| 31/5 | 38.7 | 48 | 40 | 15 | 8 | 4 | 39/1 | 12.7 | 52 | 40 | 16 | 9 | 6 |
| 31/6 | 7.4 | 37 | 32 | 5 | 1 | 3 | 40/1 | 8.9 | 32 | 19 | 5 | 2 | 1 |
| 32/1 | 34.3 | 55 | 38 | 12 | 3 | 8 | 41/1 | 3.9 | 24 | 18 | 3 | 2 | 2 |
| 32/2 | 9.8 | 55 | 53 | 21 | 10 | 9 | 41/2 | 9.2 | 20 | 13 | 2 | 2 | 2 |
| 32/3 | 18 | 61 | 48 | 25 | 17 | 11 | 42/1 | 2.1 | 34 | 27 | 16 | 7 | 8 |
| 32/4 | 12.8 | 55 | 43 | 20 | 10 | 9 | 42/2 | 3.4 | 23 | 20 | 8 | 7 | 6 |
| 33/1 | 23.5 | 52 | 39 | 14 | 4 | 7 | 42/3 | 1.0 | 27 | 25 | 8 | 6 | 6 |
| 33/2 | 19.6 | 58 | 48 | 26 | 18 | 11 | 42/4 | 5.9 | 26 | 23 | 8 | 6 | 10 |
| 33/3 | 8.4 | 47 | 43 | 22 | 11 | 8 | 43/1 | 6.9 | 20 | 17 | 8 | 5 | 6 |
| 34/1 | 4.6 | 51 | 43 | 13 | 7 | 6 | 44/1 | 6.7 | 31 | 20 | 3 | 2 | 2 |
| 35/1 | 4.9 | 31 | 22 | 4 | 2 | 2 | 45/1 | 3.7 | 18 | 15 | 10 | 8 | 17 |
| 36/1 | 5.4 | 44 | 30 | 14 | 5 | 14 | 45/2 | 53.5 | 20 | 10 | 2 | 1 | 2 |
| 36/2 | 15.6 | 44 | 35 | 14 | 6 | 12 | 45/3 | 2.8 | 12 | 7 | 10 | 9 | 8 |
| 36/3 | 11.2 | 44 | 26 | 6 | 16 | 3 | 45/4 | 1.3 | 12 | 7 | 9 | 8 | 14 |
| 36/4 | 7.1 | 39 | 29 | 13 | 4 | 6 | 46/1 | 0.7 | 9 | 6 | 1 | 1 | 1 |
| 36/5 | 5.1 | 34 | 24 | 6 | 2 | 3 | 46/2 | 3.3 | 9 | 6 | 1 | 1 | 1 |
| 36/6 | 15.4 | 37 | 31 | 10 | 7 | 11 | 46/3 | 19.1 | 14 | 11 | 1 | 1 | 1 |
| 36/7 | 2.4 | 26 | 20 | 3 | 3 | 3 | 46/4 | 1.8 | 9 | 6 | 1 | 1 | 1 |
| 36/8 | 17.4 | 32 | 29 | 7 | 4 | 3 | 46/5 | 5.5 | 12 | 10 | 1 | 1 | 1 |
| | | | | | | | TOTAL | | | | | | |
| | | | | | | | AREA =1785.0 | | | | | | |
| | | | | | | | NMP** | | 55 | 45 | 17 | 10 | 12 |
| | | | | | | | [2] | | | | | | |

[2] *PS – grazing land; FN – hay land; MR - apple; PN - plum; CT - potato

**Table 4-11. Distribution of Areas on Favorability Classes for the Main Crops in Roşia Montană Area**

| Class | PS* | | FN | | MR | | PN | | CT | |
|---|---|---|---|---|---|---|---|---|---|---|
| Quality Grade | ha | % | ha | % | ha | % | ha | % | ha | % |
| I | - | - | - | - | - | - | - | - | - | - |
| 91-100 | | | | | | | | | | |
| II | 39.3 | 2.2 | - | - | - | - | - | - | - | - |
| 81-90 | | | | | | | | | | |
| III | 119.7 | 6.7 | 39.3 | 2.2 | - | - | - | - | - | - |
| 71-80 | | | | | | | | | | |
| IV | 645.9 | 36.2 | 57.1 | 3.2 | - | - | - | - | - | - |
| 61-70 | | | | | | | | | | |
| V | 513.1 | 28.7 | 773.3 | 43.3 | - | - | - | - | - | - |
| 51-60 | | | | | | | | | | |
| VI | 27.6 | 1.5 | 441.2 | 24.7 | 20.5 | 1.1 | 20.5 | 1.1 | - | - |
| 41-50 | | | | | | | | | | |
| VII | 253.1 | 14.2 | 116.8 | 6.5 | 158.4 | 8.9 | 139.6 | 7.8 | 152.1 | 8.5 |
| 31-40 | | | | | | | | | | |
| VIII | 87.7 | 5.0 | 174.5 | 10.0 | 241.8 | 13.6 | 191.5 | 10.7 | 222.9 | 12.5 |
| 21-30 | | | | | | | | | | |
| IX | 98.7 | 5.5 | 91.1 | 5.0 | 931.6 | 52.2 | 992.2 | 55.6 | 271.5 | 15.2 |
| 11-20 | | | | | | | | | | |
| X | - | - | 91.7 | 5.1 | 432.7 | 24.2 | 441.2 | 24.7 | 1138.5 | 63.8 |
| 1-10 | | | | | | | | | | |
| TOTAL | 1785.0 | 100.0 | 1785.0 | 100.0 | 1785.0 | 100.0 | 1785.0 | 100.0 | 1785.0 | 100.0 |

Pursuant to calculating the quality grades under natural conditions for the 5 considered harvests, the followings were outlined:

- Within the territory there are no lands of class I for any of the considered harvest;
- The quality grades range within broad limits for each harvest, from one TEO to another;
- The lands over the entire area are rated into class V of favorability (with 55 points) for grazing lands, class VI (with 45 points) for hay lands, class IX (with 17 and 12 points respectively) for apple and potato harvest respectively and class X for plum, according to the weighted average quality grade, subject to the surface area (Table 4-10).

From Table 4-11 it is ascertained:

- For *grazing lands*, class IV and V of favorability cover 1159 ha (64.9%); the other classes cover the remaining lands over various surface areas.

[3] *PS – grazing land; FN – hay land; MR - apple; PN - plum; CT - potato

- For *hay fields*, the situation is sensibly close, class V and VI grouping lands with surface area of 1214.5 ha (68%), the remaining areas pertaining to the other classes of favorability; it must be noted that for this crop there are no lands of class II.
- For *apple*, there are no lands of class II and V; lands are grouped particularly in class IX and X (1364.3 ha – 76.4%); situation is similar for plum.
- For *potato*, lands are grouped in favorability classes VII – X, of which classes IX and X cover 1410 ha (79.0%) of the entire area.

## 4.7 Impact of Construction and Development of the Industrial and Ore Mining and Processing Zone on Overburden

The activities to be carried out in the gold ore mining and processing zone will affect the soil primarily due the removal of an area of approximately 1300 ha from the current agricultural and forestry circuit however due to direct impact also.
As per the data in the technical memorandum, the distribution of this area on the industrial zone components is the following: open pits - 317 ha, process plant - 44 ha, waste rock dumps - 295 ha, topsoil stockpiles - 34 ha, tailings management facility -393 ha, tailings management pond dam - 69 ha, roads -175 ha. In total there will be 1327 ha affected.
During construction and development phase the main impact is caused by the temporary or permanent loss of soil as a result of land take up. The affected zones include the open pits, waste rock dumps, tailings management facility, topsoil stockpiles, process plant, roads and ancillary facilities. Accordingly, the farming and forestry soils that have been affected by land take up may undergo deterioration due to settling of the dust resulting from the construction and development of the industrial zone.
The wind erosion of particles resulting in the pits or the deflation of materials that are either dumped or airborne during transportation may constitute pollution sources for soils remaining in the industrial zone.
During mining and processing, the impact to the soil will be caused by a number of factors, however of lower intensity than those impacting during construction and development of the industrial zone. These factors will be:

- Soil losses as a result of subsequent development. They refer to the same units as mentioned above, e.g.: open pits, waste rock dumps, tailings management facility, topsoil stockpiles, process plant, roads and ancillary facilities;
- Soil degradation as a result of the settling of suspended particles resulting from ore and waste rock mining and transport. The soils remaining within the industrial zone site will be affected and possibly the soils within the buffer zone around the industrial zone also;
- Contamination of soil with process chemicals and effluents, such as: cyanides, caustic soda, hydrochloric acid, flocculant, oils, lubricants. It is possible that the soil around the process and storage facilities and the soil alongside the roads be thus contaminated;
- The topsoil that has been stockpiled deteriorates due to several causes, e.g.: erosion, leaching, compaction, alteration of organic matter.

Herein further we will analyse the main factors contributing directly to the impact to the soil.

**Temporary or Permanent Loss of Soil as a Result of Land Take Up**
Land will be taken up by: open pits, waste rock dumps, tailings management facility, topsoil stockpiles, process plant, roads and ancillary facilities.

The total area estimated for the land taken up by the ***open pits*** will be 317 ha. Of this area a large part, especially in the Cetate and Cîrnic pits is taken up by outcropping rocks. Only 124 ha of the pit footprint are taken up by actual soils.

The soil area within the ***Cetate pit*** site is 18.52 ha, covered to a great extent (18.02 ha) by acid andi, lithical or typical bruni soils. Bruni eu-mesobasic soil occurs over a small area of 0.5 ha.

The entire soil area within the future ***Cîrnic pit*** (33.35 ha) is covered in andi acid bruni soils in association with typical lithosols. These soils cover 86% of the future ***Jig pit*** (31.59 ha). The balance is represented by regosols in association with lithosols over about 8% of the area and by bruni eu-mesobasic soils over 6% of the area.

However, within the future ***Orlea pit*** located at a lower elevation prevails the bruni eu-mesobasic soil over an area of 21.6 ha representing 54% of the entire area (40.2 ha). Lithosols cover around 34% of the area with the balance of 12% being covered by bruni acid lithic or andi soil in association with typical lithosols.

Having looked at the entire area to be taken up by the open pits, namely the area covered by soils (124 ha) we see that 83.7 ha (67.5%) is taken up by andi or lithic acid bruni soils, 23.9 ha (19.3%), by bruni eu-mesobasic soils, 13.9 ha (11.2%) by lithosols and 2.5 ha (2%) by regosols.

The two ***topsoil stockpiles*** located on the Schilone Hill or in the Corna area will take up areas of 16.88 ha and 22.2 ha, respectively. In the first case, the 16.88 ha are mainly formed of regosols in association with lithosols (82% of the area), the 18% balance being represented by acid andisols in association with cambi andisols. The area to be taken up by the Corna topsoil stockpile is covered entirely by andi-lithic acid bruni soils in association with typical lithosols.

Therefore, the topsoil stockpiles will take up 25.2 ha of acid bruni soils in association with typical lithosols, mainly andi-lithic soils and 13.9 ha of lithic regosols in association with lithosols. In percentages, the acid bruni soils in association with typical lithosols will represent 64.5% and the lithic regosols in association with lithosols will represent 35.3% (Table 4-12.).

***The Cetate and Cîrnic Waste Rock Dumps*** will take up 45.8 ha and 140.77 ha, respectively. The overburden on which the waste rock will be dumped is formed of typical andi or lithic bruni acid soils. The soils prevailing at both locations are acid bruni soils, e.g. 58% (of 45.8%) at Cetate and 88% (of 140.77 ha) at Cîrnic. The balance is covered 21% and 11%, respectively by bruni eu-mesobasic soils. In addition on Cetate waste rock dumps regosols are present over 6.1 ha, which is equivalent to 13% of the total area. The 8% balance (3.5 ha) is covered by the current Cetate waste rock dump.

Therefore the two waste rock dumps site is covered over 150.17 ha (80% of the total area) by andi or lithic typical acid bruni soils in association with typical or lithic bruni eu-mesobasic soils. Lithic and typical regosols are present over 3.2% of the area and waste rock material from the current dump is present over 3.1% (Table 4-12.).

***The Cetate Low Grade Ore Stockpile***, comprising two bodies to be developed in time and reach areas of 25.44 ha and 58.15 ha will cover typical or lithic acid bruni soils in association with cambi andisols in area of 68.49 ha, lithic regosols in association with typical lithosols in area of 8.1 ha and typical or lithic bruni eu-mesobasic soils in area of 3.1 ha. In relation to the total area the three groups of soils represent 82%, 9.7% and 3.7%, respectively (Table 4.6.1.).

***The Limestone Quarry*** will affect an area of 5.36 ha formed mainly of typical and lithic acid bruni soils in area of 5.06 ha (94.4% of the total area) and typical or lithic bruni eu-mesobasic soils (Table 4-12.).

***The Process Plant*** will take up an area of 39.0 ha and will mainly involve excavation of overburden constituted 95% of typical, andi, andi-lithic acid bruni soils in association with cambi andisoils. The lithic regosol in association with typical lithosol take up 5% of the area of land which will affect the construction of the process plant (Table 4.12.).

***The Corna Tailings Management Facility*** will eventually take up an area of 324 ha. Once commissioned and the ultimate elevation reached there will be 137.9 ha of typical, andi or lithic acid bruni soils in association with typical lithic soils covered and 168.2 ha of typical, lithic bruni eu-mesobasic soils in association with typical lithosols. These two prevailing types of soil represent 43% and 52%, respectively of the entire area to be taken up by the TMF.

There will be another two types of soils present within the TMF footprint, but covering smaller areas, of only 11.5 ha (3.5%) for regosol associated with typical lithosol and 1.5 ha (0.5%) for typical lithosol.

An area equivalent to 1% of the entire TMF area will come from the Cîrnic waste rock dump area (Table 4-12.).

From the overall analysis of the distribution of the soil types to be affected either by permanent or temporary loss, it results that 63% of the area is covered by the acid bruni soil with various sub-types e.g. typical, lithic, andisoil most frequently associated with the typical lithosol and 28% is represented by the bruni eu-mesobasic soil with its sub-types e.g. typical, andi or lithic, frequently associated with the typical lithosol. The 9% balance is represented by other soil types and sub-types such as regosol or lithosol or even waste rock material from the current dumps.

Should we analyse the quality of these soils we will see that:

***Acid Bruni Soils***, as outlined by their name have an acid reaction from strong to moderate ( $pH_{H_2O}$ 4.7-5.8). From a chemical standpoint they are characterized by:

- Various mobile Al contents, from low to high;
- Predominantly low humus contents, although the value of the organic matter contents is high in some places, particularly grazing and hay lands. The high value is due to rootlet remnants;
- Generally low mobile phosphorous contents. The low mobile phosphorous content is a constant characteristic of the overburden in the area;
- Various mobile potassium contents, ranging from low to high values with a predominantly average supply;
- Cationic exchange capacity of these soils is generally small-average;

***Bruni Eu-Mesobasic Soils*** have a moderate – low acid reaction, sometimes even neutral;

- Humus content is low to average similar to the total nitrogen content;
- Mobile P content is low and mobile K content has values indicating both an insufficient as well as good supply;
- Cationic exchange capacity is low to moderate.

In terms of the favorability of these two main soil types to the plants cultivated in the area, they are rated into classes V-VI (with 60 – 40 points) for grazing and hay lands and classes IX – X (with 20 – 0 points) for apple tree, plume tree and potato.

**Table 4-12. Percentage Distribution of Main Soil Types Within the Future Industrial Facility Sites Against the Total Area Covered with Soil to be Taken Up by the Project**

| Industrial Site | Total Area (ha) | Main Soil Type | | | | |
|---|---|---|---|---|---|---|
| | | Bruni Acid Soil | Bruni Eu-Mesobasic Soil | Regosol | Lithosol | Existing Tailings |
| Open Pits | 124.00 | 67.5 | 19.3 | 2.0 | 11.2 | |
| Waste Rock Dumps | 186.60 | 80.0 | 13.7 | 3.2 | 3.1 | |
| Low Grade Ore Stockpile | 83.60 | 82.0 | 3.7 | 9.7 | | 4.6 |
| Topsoil Stockpiles | 39.80 | 64.5 | | 35.5 | | |
| Limestone Quarries | 5.36 | 94.4 | 5.6 | | | |
| Process Plant | 39.00 | 95.0 | | 5.0 | | |
| TMF | 324.00 | 43.0 | 52.0 | 3.5 | 0.5 | 1.0 |

## 4.8 Thickness and Surface Area of Fertile Soil Layer Affected by the Roşia Montană Operations

In Table 4-13. are presented five groups of the fertile soil layer thickness, e.g.: thickness smaller than 10 cm, between 10 and 20 cm, between 10 and 30 cm, between 20 and 30 cm and between 30 and 40 cm.

The distribution of these groups subject to the industrial facilities that are to operate in the area indicates that the largest part (58% of the area to be affected) pertains to soils with fertile layer thickness either smaller than 10 cm or ranging between 10-20 cm, followed by fertile layer with 20-30 cm thickness (23%), then 10 -30 cm thick fertile layer (14%), and only 5% represents soils with fertile layer thickness ranging between 30 – 40 cm.

The distribution of these areas on industrial facilities indicate the same sequence for pits, TMF, waste rock dumps. In terms of the process plant and low grade ore stockpile prevail soils with fertile layer of 20-30 cm. The soils with the deepest fertile soil of 30-40 cm pertain to the areas to be taken up by the topsoil and low grade ore stockpiles.

Should we analyze this distribution subject to the nature of the industrial facilities we see that it is judicious, e.g.: the facilities that will remove the soils from the productive circuit definitively will take up soils with thin fertile layer, smaller than 10 cm or ranging between 10 – 20 cm, whereas the facilities that will take up the soil temporary such as the low grade ore and topsoil stockpiles will cover areas with soils having a deeper fertile layer of 20-30 cm or 30-40 cm.

**Table 4-13. Distribution of soil areas on which industrial facilities will be located subject to the fertile soil layer thickness**

| Location | Fertile Layer Thickness (cm) | | | | |
|---|---|---|---|---|---|
| | < 10 | 10-20 | 10-30 | 20-30 | 30-40 |
| Cetate Pit | 9.3 | | | 9.2 | |
| Cîrnic Pit | 26.2 | 4.7 | 2.5 | | |
| Jig Pit | 2.8 | 27.3 | | 1.5 | |
| Orlea Pit | 16.2 | 4.1 | | 19.9 | |
| Limestone Quarry | | 0.3 | 0.4 | 4.7 | |
| *Total Open Pits* | *54.5* | *36.4* | *2.9* | *35.3* | |
| TMF | 103.8 | 95.8 | 70.6 | 48.9 | |
| Process Plant | 1.9 | | | 37.1 | |
| Cîrnic Waste Rock Dump | 28.3 | 85.6 | 25.6 | | |
| Cetate Waste Rock Dump | 6.1 | 9.7 | | 26.5 | |
| *Total Waste Rock Dumps* | *34.4* | *95.3* | *25.6* | *26.5* | |
| Cetate Low Grade Ore Stockpile | 17.6 | 3.1 | | 30.6 | 28.75 |
| Corna Topsoil Stockpile | 4.5 | 7.0 | 10.7 | | |
| Schilone Topsoil Stockpile | 0.3 | 2.4 | | 0.6 | 13.5 |
| *Total Topsoil Stockpile* | *4.8* | *9.4* | *10.7* | *0.6* | *13.5* |
| GRAND TOTAL (HA) | 217 | 240 | 109.8 | 179 | 42.2 |
| % OF TOTAL | 27.5 | 30.5 | 13.9 | 22.7 | 5.4 |

## 4.9 Quantities of Organic Matter (Humus) That May be Lost Permanently or Temporary

Calculation of the quantities of organic matter (t) lost off he areas on which industrial facilities will be located are presented in Table 4-14. The total quantity of affected organic matter (humus) will be 113 577 t.

Of the facilities to contribute to the permanent loss of humus, the tailings management facility will cause the permanent loss of the largest quantity of humus, e.g. 38 146 t. The organic matter of the soil stripped off the process plant site (7 496 t) and pits may be partially recovered should it be taken to the topsoil stockpile.

The temporary loss of humus will occur in the areas proposed for the waste rock dumps and low grade ore and topsoil stockpiles. We note that the fertile soil will be stripped off the future waste rock dump sites and taken to the topsoil stockpiles.

The waste rock dumps, particularly the Cîrnic dump will generate the largest quantity of humus lost temporarily (32 735 t). In descending order this is followed by the low grade ores stockpile e.g. 14 642 t and topsoil stockpiles, e.g. 4 356 t.

**Table 4-14. Quantities of Organic Matter (Humus) That May be Lost**

Permanently or Temporary from Land Areas on Which Industrial Facilities Are To Be Located

| Industrial Site | Quantity of Lost Organic Matter (Humus) (t) |
|---|---|
| Cetate Pit | 2865 |
| Cîrnic Pit | 3894 |
| Jig Pit | 3279 |
| Orlea Pit | 5097 |
| Limestone Quarry | 1067 |
| *Total Open Pits* | *16202* |
| Tailing Management Facility | 38146 |
| Process Plant | 7496 |
| Cîrnic Waste Rock Dump | 25251 |
| Cetate Waste Rock Dump | 7484 |
| *Total Waste Rock Dumps* | *32735* |
| Cetate Low Grade Ore Stockpile | 14642 |
| Corna Topsoil Stockpile | 3201 |
| Schilone Topsoil Stockpile | 1155 |
| *Total Topsoil Stockpiles* | *4356* |
| GRAND TOTAL | 113577 |

We must note that the storage of the topsoil in the two stockpiles will, to a certain extent, lead to degradation of the organic matter as a result of compaction, anaero-biosis or water and air erosion, should special measures not be taken. Accordingly, the removal of the humus from the biotic circuit will contribute to the alteration of some of its proprieties due to the change of the microbiological composition of the soil matter that is in various humification stages.

### *4.9.1 Loss of nutrient elements*

Once the fertile layer is stripped, partially stockpiled or definitively covered, as he case with the TMF, a significant amount of nutrient elements will be removed from the farming or forestry circuit. Some of this amount will be reintegrated to this circuit as the stockpiled topsoil will be used for environmental rehabilitation of the area including the overburden, where suitable.

In order to quantify this fact, the amounts of mobile P and mobile K to be lost by removing the topsoil layer in thickness of 0-20 cm have been calculated (Table 4-15). The overall amount of P deriving from mobile P estimated to be lost is 38 216 kg and the amount of K deriving from the mobile form also is 351 330 kg.

Distributed on industrial facilities, a descending sequence of the amounts of lost K and P subject to the soil nature and primarily to the contents in nutrients of the soil is noted. The analytical data returned by the agrochemical mapping was used to calculate these amounts.

As per the data in Table 4-15. the highest losses are also definitive and they will occur at the tailings management facility. They will amount to approximately 26 268 kg P and 142 767 kg K. Given that the TMF will be eventually filled with tailings material, these amounts of P, K and other nutrients will essentially enter a geological deposition period. They will be returned to the external chemical elements circuit at such time when a “landscape reshaping” will occur, process that is not desirable.

The balance of 11 948 kg P and 208 563 kg K from the 0-20 cm layer to be stripped off the sites where the other industrial facilities will be constructed, will be returned to the farming or forestry circuit as the stockpiled topsoil will be used to rehabilitate the area.

Apart from these estimations regarding the loss of mobile P and K, we must take into account that the actual losses will be higher, on one hand due to the diversity of the chemical composition of the soil and on the other hand due to use in the calculation of the content values of the mobile form of the chemical elements only. Thus, there are other macro-elements included in the chemical composition of the soil also e.g. N, Ca, Mg, S, Fe or micro-elements e.g. Mn, Cu, Cd, Cr, Co, Ni, Pb, Zn, etc. Should the values of the total contents of the macro and micro-elements be used in the calculation, the final losses would be 80 – 90% higher.

Given the principle according to which in nature nothing is lost but everything is transformed we may state that the losses of any nature that will occur as a result of the construction of the industrial, gold ore mining and processing zone will be encountered under other forms even if some of them in historic or geological times, in the general circuit of the matter.

**Table 4-15. Estimated Losses of Mobile Phosphorous and Potassium In the 0-20 cm Layer**

Of The Soils in Areas Where Industrial Facilities Are To Be Constructed

| Industrial Facility | kg P | kg K |
|---|---|---|
| Orlea Pit | 544 | 18108 |
| Jig Pit | 1126 | 17946 |
| Cetate Pit | 445 | 9340 |
| Cîrnic Pit | 1205 | 18995 |
| Limestone Quarry | 128 | 2424 |
| Cîrnic Waste Rock Dump | 3735 | 65699 |
| Cetate Waste Rock Dump | 1015 | 15798 |
| Process Plant | 936 | 12603 |
| Cetate 1 Low Grade Ore Stockpile | 526 | 1290 |
| Cetate 2 Low Grade Ore Stockpile | 1396 | 29764 |
| Schilone Topsoil Stockpile | 405 | 5274 |
| Corna Topsoil Stockpile | 487 | 11322 |
| Tailings Management Facility | 26268 | 142767 |
| Total | 38216 | 351330 |

### *4.9.2 Other Ways of Soil Degradation as a Result of the Construction, Development, Ore Mining and Processing Activities*

Another pollution source which will be active over the entire construction and development of the industrial zone and even during ore mining and processing is represented by *dust*. The dust consists of mineral particles with the diameters, as accepted by the soil science, ranging between 0.02 and 0.002 mm.

Where the investigated area is concerned, dust will be generated as a result of blasting and excavation, during ore haulage to the process plant, ore processing, starting with ore stockpiling, crushing, grinding although the plan is for these operations to be carried out in the final phase in wet media.

The other technological operations to be carried out within the sites do not pollute the air and hence the soil with suspended particles.

Other potential dust sources occur on waste rock dumping and due to dust being airborne off the dry surfaces of the TMF.

It is evident that in the dust composition there will be chemical mineral components deriving from the rock and ore composition e.g. Si, Al, Fe, Ti, Ca, Mg, Ni, K, Mn, Cu, Zn, Cd, Pb and even traces of precious metals.

The dust airborne off the tires of the haulage vehicles in general and ore haulage vehicles in particular, driving on dirt roads will also contain chemical elements constituent of the lithological formations they intersect. However, apart from these elements it is possible that the soil alongside the roads to be contaminated with Pb from petrol combustion engine exhaust gases. Cd, Cu, Cr, Ni, Zn may also occur in addition to Pb.

Another potential dust source may be the concrete plant.

The intensity of the impact of dust on soil depends on several factors, such as: distance to the major dust generating sources, direction of prevailing winds.

Another major transport source of the dust from undeveloped or less developed areas is represented by water erosion. It may occur in the dump and topsoil stockpile sites.

Dust pollution does not have a sustainable negative impact to the soil. The negative impact is primarily caused to vegetation by dust settling onto foliage generating partial or total closure of the stomata and disturbance of the physiological and biochemical processes of the plants.

However, where dust is loaded with heavy metals, it is possible that a pollution process with such elements be initiated within the soils the dust settles on.

Given the employed technology particularly the process plant equipment and hazardous substances circuit, as described in the technical memorandum for secure of the environmental endorsement, the probability for soil contamination with process chemicals and effluents, such as: cyanides, caustic soda, flocculant, lubricants is very low. Impact mitigation measures are provided for accidental situations.

Another soil accidental pollution source may be the failure of the process water pipelines running from the process plant to the TMF or failure of the decant water return pipeline running from the TMF to the process plant.

The stockpiled topsoil will be subjected to a degradation process as a result of the change of the physical-chemical and particularly biological conditions. Apart from the erosion occurrence should special measures to mitigate leaching, compaction, anaerobic environment presence not be taken, micro-biological and chemical changes will take place posing a degrading impact on the organic matter quality, loss of nutrients by increase of the mobility of the variable valence chemical elements.

In conclusion, the matrix of the factors with polluting impact to soil generated by the industrial facilities during their construction and operation is presented (Table 4-16.).

**Table 4-16. Impact of various pollution sources on Roşia Montană soils**

As a result of the construction, development of industrial facilities and gold ore mining and processing activities

| Impact Nature | Area affected by industrial facilities under construction and operation | | | | | | Area not affected by the construction and operation of the industrial facilities |
|---|---|---|---|---|---|---|---|
| | Pits | Process Plant | TMF | Dump | Low Grade Ore Stockpile | Topsoil Stockpile | |
| Total soil loss | X | | X | | | | |
| Temporary soil loss | | X | | X | X | X | |
| Settling of dust generated by the construction, mining and processing activities | | | | | | X | X |
| Contamination of soil with process chemicals | | X | X | | | | |
| Failure of process waste water pipelines running to and from TMF | | | | | | | X |
| Degradation "in situ" of stockpiled topsoil | | | | | | X | |

# 5 Conclusions

1) The site investigated as part of the soil impact assessment generated by the Roşia Montană gold ore mining and processing activities has a surface area of 1785 ha. It is bordered in the north side by the Roşia and Vîrtop streams interfluves, in the east side by the interfluves separating the springs of the Virtop, Roşia and Corna streams from the watershed of the streams running north-eastward towards the Aries river or eastward, in the south side the site is bordered by the Corna – Abruzel stream interfluves, in the west side by an imaginary north-south line that links the north part of the Iacobesti village crossing southward the Sălişte Hill, Sălişte stream, Bailesti Hill with the Corna valley.
2) The overburden is constituted of bruni eu-mesobasic soils with typical and lithic subtypes (BMti, BMls) and acid bruni soils with typical, andi, lithic, andi-lithic subtypes (BOti, BOan, BOls, BOan-ls), both types belonging to the cambisol class and of typical regosols (RSti), typical colluvisols (COti) and typical lithosols (LSti), all three belonging to the non-evolved, truncated or loose soils class. The acid bruni and bruni eu-mesobasic soils prevail.
3) The predominant reaction of the soils is acid-strongly acid over 52% of the area and mildly acid over 40% of the area. The supply of raw organic matter is average-high over 99% of the area however the humus content is low. The supply with nitrogen is predominantly average, with mobile phosphorous is poor to very poor over 96% of the area and with the mobile potassium is average to suitably supplied over 92% of the area.
4) Soils are predominantly skeleton-like with low-moderate skeleton content, in horizon A, over 57% of the area and low-excessive over 14% of the area. The prevailing texture in horizon A is clayish over 57% of the area and clayish-sandy over 38% of the area.
5) The fertile layer thickness is generally small. Over 26% of the area it is less than 10 cm, over 26% it ranges between 10 and 20 cm, over 27% between 10 and 30 cm and over 17% between 20 and 30 cm. Overall, 70% of the area of the investigated soils have the fertile layer thickness up to 30 cm.
6) The overburden within the Roşia Montană area is poorly or averagely populated with fungi or bacterial micro-flora, has a relatively moderate biodiversity e.g. 2-4 species of fungi and 1-9 species of bacteria and relatively balanced and homogenous taxonomic communities. The overall physiological activities of the edaphic micro-flora have an average intensity with the majority of the soil respiration values ranging between 30 and 80 mg $CO_2$/100 g soil.
7) The overburden within the Roşia Montană area is not polluted with heavy metals.
8) The overburden has a moderate favorability (40-60 points) for grazing and hay lands and small favorability (0-20 points) for fruit trees (apple, plum) and potato.
9) The impact of the construction and development of the industrial, mining and processing zone involves mainly the total or temporary loss of land and secondly the settling of process dust onto areas of land not affected by the construction or operation phases.
10) The soil may be accidentally polluted with process chemicals and wastewater on its way to or from the tailings management facility.
11) The total area of land to be affected by the construction, development, mining and processing activities will be 1327 ha distributed as follows: 317 ha – open pits, 44 ha – process plant, 295 ha – waste rock dumps, 34 ha – topsoil stockpiles, 393 ha – tailings management facility, 175 ha – roads.

12) The industrial facilities to be removed definitively from the productive circuit (TMF) will take up areas with a thinner fertile layer, below 10 cm or ranging between 10 and 20 cm, whereas the industrial facilities which will remove temporarily (dumps, topsoil stockpiles) the soils from the productive circuit will take up areas with soil having a deeper fertile layer of 20 – 30 cm or 30 – 40 cm.

13) The total estimated amount of organic matter (humus) to be lost entirely or temporarily is 113577 t. Of this, 162002 t will represent the open pits, 38164 t - TMF, 7496 t- process plant, 32735 t – waste rock dumps, 14642 t - low grade ore stockpile and 4356 t – topsoil stockpile.

14) Along with the loss of topsoil there will be 38216 kg of P and 351330 kg of K lost estimated according to the mobile forms of P and K. The losses of chemical elements would be much higher of up to 80 – 90% should estimation had been done according to the total contents and should the overall chemical composition, quantitative and qualitative have been taken into account.

15) Losses of any nature, related to soil, which will occur as a result of the construction and development of the industrial sites and gold ore mining and processing activities will be encountered in other forms, even if some of them in historic or geological times in the external circuit of the matter.

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