Copper mining in the Mansfeld region was first mentioned back in the year 1199. Numerous dumps of unsmeltable copper-schicht and slag give evidence of the one time intensive mining in the Mansfeld area (WITZKE und PÖLLMANN, 1996). The mining and smelting activity of copper-schist in this area was terminated since many years.

The copper mining industries in Mansfeld area have left almost 2000 waste dumps. About 50 Million tons applicable copper slags which are remains of the 800 years of copper production are stored in the area of Eisleben / Helbra.

Those copper-slag-dumps of Helbra, which are used in this research work, are stored, contrary to those, which are covered with plants, without any cover of vegetation.

In spite of this huge amount, there is no indication of any substances of the copper-slags in the surrounding soil, sea sediments and waters (SCHRECK, 1997).

As a result, from the environmental technical reasons point of view, the copper slags do not cause any harm if utilised properly.

The copper-slags consist of mainly glass and Fe-, Mg-, Ca-silicates (WITZKE und PÖLLMANN, 1996). Examination of the copper slag has been also performed by several authors such as WITZKE (1997) and GALONSKA (1997).

Moreover, the question of using the copper slag as alternative building material is discussed, by, among others, PENTINGHAUS et. al. (1997) and VIEHL (1997).

Compared to those pig-iron slags, of which the degree of utilisation is almost 100%, the Mansfeld copper-slags are used very seldom (LEEDER et al. 1989).

So far, this particular copper slag has been used exclusively in road constructions. In view of restoration of the Mansfeld district, with the aim of reducing its dump areas, researches should be made so as to assure further applications of the copper slags.

It is the aim of this research to contribute to this idea; and it is divided into two parts, which are explained in short below.

1) The first part deals with the examination of the application of copper slag in immobilising hazardous elements through formation of mineral reservoirs (HAMROLL und PÖLLMANN, 1997, PÖLLMANN et al., 1986 und PÖLLMANN, 1998). These can be formed by thermal treatment of an appropriate mixture (primary mineral reservoirs) as well as by hydraulic reactions (secondary mineral reservoirs). The effect of
mineral reservoirs is based on the fixation of detrimental cations and anions in their lattice (NEUBAUER, 1992). Some examples of mineral reservoirs are listed in the following.

<table>
<thead>
<tr>
<th>Primary mineral-reservoir</th>
<th>Secondary mineral-reservoir</th>
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<tbody>
<tr>
<td>Ellestadite $\text{Ca}_{10}[(\text{SiO}_4)_3(\text{SO}_4)_3(\text{Cl,OH,F})_2]$</td>
<td>Ettringite $\text{Ca}_6[\text{Al}<em>2(\text{OH})</em>{12}.24\text{H}_2\text{O}][(\text{SO}_4)_3.n\text{H}_2\text{O}]$</td>
</tr>
<tr>
<td>Ternesite $\text{Ca}_9[(\text{SiO}_4)_2\text{SO}_4]$</td>
<td>Calciumsilicatehydrate $\text{CaO}(y)\text{SiO}_2(n)\text{H}_2\text{O}$</td>
</tr>
<tr>
<td>Nasonite $\text{Me}_6\text{Me}_4[(\text{Si}_2\text{O}_7)_2\text{Cl}_2]$</td>
<td>Zeolite $((M^{II},M^{I})\text{O.Al}_2\text{O}_3.(x)\text{SiO}_2(y)\text{H}_2\text{O})$</td>
</tr>
</tbody>
</table>

It could be shown in this research that primary mineral reservoirs could be formed by thermal treatment of an appropriate mixture of Mansfeld-copper-slags, MSWI-residue, gypsum from flue gas desulfurizing plant and limestone fine in a static experiment at a laboratory scale. Through formation of mineral reservoirs, the leaching out of heavy metals (which originated from MSWI) could be highly decreased, so that it could be kept below the permitted leaching-values, which the technical instructions on municipal wastes for dump category II (Technische Anleitung-Siedlungsabfall Deponieklasse II) stipulates.

Afterwards the possibility of transferring these results into a dynamic technical process using a laboratory kiln was also carried through. The leaching ability of the heavy metals of this dynamic experiment was much more lower than that of the static experiments.

2) The second part deals with the synthesis of alinite cement (OBERSTE-PADTBERG et al., 1989, MOTZET et al., 1994) out of copper-slag, MSWI-residues and limestone fine. Alinite cement is a chloride bearing hydraulic binder, which can replace Portland cement in many fields (MOTZET, 1994). Alinite cement can be applied generally in mining mortars, expansive cements, rapid hardening binders and in landfill technologies (PÖLLMANN et al., 1995). Alinite cement is produced in Eastern Europe and in CIS (Commonwealth of Independent States) and is applied in construction fields within the magnitude of approximately 100,000 t/a (MOTZET et al. 1994).

The main characteristics of alinite are:
- high early strength
- rapid hardening time
- processibility at low temperatures (<5°C)
application as building material in landfill sites (MOTZET und ZYSK, 1994).

It could be shown in this research that alinite could be synthesised by thermal treatment of an appropriate mixture of copper-slag, MSWI (Municipal Solid Waste Incineration) residues and limestone fines (to correct the chemistry of the mixture). Mineral reservoirs such as Chlorellestadite could also be formed along with alinite. The leaching out of heavy metals, which originated from MSWI, was very much lower than the permitted leaching-values according to the technical instructions on municipal wastes for dump category I*. Heatflow calorimetric investigations on this alinite-mixture showed earlier hydration behaviour. The hydration took place during the first two hours.

As a result of this research work, two possible applications of Mansfeld copper-slag could be shown:

1. Usage for immobilising of detrimental substances and
2. Usage for production of special cement.

* In accordance with the third administrative regulation on waste avoidance and management of 14 May 1993 belong those wastes, which contain very little organic part and which show a lower release of pollutants during a leachability test, to dump category I (Deponieklasse I).

To dump category II (Deponieklasse II) belong those wastes, which contain higher organic part than those of dump category I and which release also higher amount of pollutants than those of dump category I during a leachability test.