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Natural remediation of mine waste-dumps – mapping the evolution of vegetation cover in distinctive geochemical environments.

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Introduction
Abandoned mine waste-dumps are focus of environmental impact, especially when there are reactive minerals, such as sulfides. From their oxidation results long lasting typical impacts, especially acid mine drainage (AMD) and contamination of soil.
Developed countries with mining tradition face, today, the need to minimize these impacts. Natural attenuation is often relevant and sometimes is enough to promote remediation. However, in the presence of abundant sulfide-rich wastes, technical intervention is generally necessary. In this context, phytoremediation has been considered appropriate, since it is a cost-effective strategy, which is a crucial expectation for abandoned mines.
The present work is focused on remediation promoted by natural vegetation of distinctive mine waste-dumps. They were analyzed with the following objectives: i) mapping cover vegetation and monitoring the success of environmental rehabilitation; ii) study the influence of geochemical and mineralogical parameters in natural colonization; iii) estimate the value of local flora for phytoremediation.

Methods
Three mines, located in different climatic, hydrological, and paragenetic environments, were selected as study cases (Cerdeirinha, Lapa Grande and Penedono, Portugal). Monitoring of vegetation cover was performed by remote detection methods, particularly, aerial photographs and satellite images (between 1980 and 2010).
Standard methods for water analysis were adapted, according with Valente and Leal Gomes (in press), in order to describe AMD. Ore petrography, X-ray diffraction and electron microscopy were used to characterize mine wastes.

Results and discussion
The waste-dumps of Cerdeirinha and Lapa Grande are located in Northwest of Portugal. They resulted from exploitation of W until the end of the eighties. They differentiate among them by the abundance of iron sulfides, by their proportion relatively to skarn minerals and by the granularity of the wastes. At Cerdeirinha, the wastes are more reactive due to the highest proportion of sulfides and to their small grain size.
Although located in the same geographic area and resulting from similar ore paragenesis, these two sites revealed different evolution: Cerdeirinha has clear evidences of reactivity, namely AMD and the secondary soluble sulfates, which are absent at Lapa Grande.
This geochemical and mineralogical differentiation is also reflected in the state of natural rehabilitation. While Lapa Grande was rapidly colonized by local flora (mainly Cytisus sp. and Ulex sp.), Cerdeirinha took long and only now begins to show signs of successful colonization.
The waste-dumps of Penedono are located in Northeast of Portugal, resulting from the exploitation of Au. Arsenopyrite is the dominant sulfide mineral. Previous studies by Abreu et al. (2007) present evidences of AMD, namely acidic effluents and metallic contamination. These authors gave the first reference about natural revegetation at this site, demonstrating the potentialities of Pinus pinaster and Cytisus multiflorus for phytoremediation strategies. Although some areas present abundant colonization, the present study demonstrates the difficulty of natural revegetation, especially in the most reactive portions, covered by secondary arsenate minerals. Here, vegetation is absent or poorly developed with sparse colonization by gramineous species (Agrostis sp.).

Conclusion
Remote detection tools for mapping vegetation growing in mine waste-dumps were used for monitoring the environmental rehabilitation of old mines between 1980 and 2010. Results suggest that mineralogical parameters determine the success of natural colonization and allow to recommend appropriate species for phytoremediation purposes.

References

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