

Groundwater quality in an abandoned metal extraction site: the case study of Campello Monti (NW Italy)

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Extractive activities present threat to natural water systems and their effects are observed even after the cessation of activities. The harmful effects of extractive activities such as deterioration of water sources by low quality waters or by allowing leaching of metals into groundwater makes it necessary to carry out careful, scientific and comprehensive studies on this subject. Consequently, the same problem statement was chosen as part of a PhD research Project. The PhD research is part of REMEDIATE project (A Marie Skłodowska-Curie Action Initial Training Network for Improved decision making in contaminated land site investigation and risk assessment, Grant Agreement No. 643087). The current work thus points out on the contamination of groundwater sources due to past mining activities in the area. Contaminated groundwater may act as possible contamination source to surface water also.

The impacts on water systems connected to mining activities depend on the ore type, metal being extracted, exploitation method, ore processing, pollution control efforts, geochemical and hydrogeochemical conditions of water and surroundings. To evaluate the effects posed by past metal extracting activities the study was carried out at an abandoned site used for extracting nickel in Campello Monti (Valstrona municipality, Piedmont region, Italy).

Campello Monti is located in basement of Southern Italian Alps in the Ivrea Verbano Zone. The area is composed of mafic rocks intruded by mantle periodite. The mafic formation consists of peridotites, pyroxenites, gabbros, anorthosites, gabbro-norite, gabbro-diorite and diorite. Mines were used for nickel exploitation from 9th Century and continued until 1940s. The long history of nickel extraction has left the waste contaminated with Ni and Co in the mountains alongwith tunnels used for carrying out metal extracting activities. The area around the site is used for housing, shows the presence of domestic animals and has Strona creek passing through it. The groundwater circulation takes place in fractured rocks, in waste dumps and tunnels used for extracting metal. Thus the abandoned site may contaminate local water sources.

To study the impacts on local water sources, water sampling and analysis were performed. Three sampling campaigns in June, July and October 2016 resulted in 16 groundwater samples (4 tap water samples, 3 samples from tunnels and 9 from springs) and 6 surface water samples. The samples were analyzed to measure alkalinity, electrolytic conductivity, pH, temperature, metals such as- Hg, Tl, Cd, Cr (total), Cr (VI), Ag, As, Pb, Se, Ni, Co, Mn, Al, Fe, Cu, Zn, B and metal ions -CN-, F⁻, Mg²⁺, Na⁺, SO₄²⁻, NO₃⁻, Cl⁻.

The water samples collected from tunnels showed nickel concentration ranging from 31.9 $\mu\text{g/l}$ to as high as 304 $\mu\text{g/l}$ (permissible limit for Ni in Italy according to DLgs. 152/06 is 20 $\mu\text{g/l}$). These groundwaters, being in close association with minerals containing heavy metals tend to dissolve such elements. The springs in mountains also contained Ni higher than 20 $\mu\text{g/l}$. These all groundwater systems act as source to Strona creek which showed Ni concentration of 512 $\mu\text{g/l}$.