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MILLING & SIEVING

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OPTIMIZING MINERAL ANALYSIS: ADDRESSING SAMPLE PREPARATION, HEALTH, TIME CHALLENGES AND RECYCLING ASPECTS

Sample preparation in the mining sector is crucial for accurate mineral analysis. Despite technological advancements, the industry faces persistent challenges. Contamination during sample collection and preparation can skew results, leading to incorrect conclusions about ore quality. Achieving representative and homogeneous samples is difficult due to the heterogeneous nature of mineral deposits. Ensuring uniform mixing in fine grinding is vital for accurate analytical results, reducing sampling bias.

The physical hardness of some ores poses challenges to crushing and grinding, potentially causing equipment wear and increasing costs. Time constraints and the pressure to deliver rapid results often lead to shortcuts in sample preparation, compromising quality. As the mining industry explores more remote and diverse deposits, innovative solutions are needed to ensure accurate and efficient mineral analysis. Addressing these challenges is crucial for optimizing resource extraction and ensuring economic viability. Last but not least health issues also become more and more important, as inhaling dust from samples during sample preparation must be avoided.

Recycling issues in the mining industry are gaining importance due to environmental concerns and resource scarcity. Mining operations generate significant waste, including tailings and slag, which pose environmental hazards if not properly managed. Recycling these materials can mitigate environmental impacts, reduce waste, and recover valuable metals, contributing to more sustainable mining practices. Extracting valuable components from mining waste requires advanced technologies and effort in R&D to discover the potential of producing new materials from waste.

Combination Unit Jaw Crusher BB 250 and Disc Mill DM 200 with Cyclone

Vibratory Disc Mill RS 200

RS 200		
Position of sampling	**Conc.Ta 1 grinding [mg/g]**	**Conc.Ta 2 grinding [mg/g]**
Surface 120°	41.15	41.23
240°	40.39	41.49
360°	40.79	40.41
Center 120°	41.09	40.19
240°	41.24	40.46
360°	40.38	41.15
Bottom 120°	41.61	40.29
240°	40.90	40.34
360°	41.15	40.71
Mean Value	40.96	40.69
Standard deviation	0.40	0.47

Table 1 : RS 200 Sample concentration

Retsch offers solutions for each of the aspects

1) Requirement to save operational time, avoid sample loss, cross contamination and dust
2) Assuring sample homogeneity with inhomogeneous samples for most reproducible analysis
3) The need powerful and versatile mills to tackle even the most challenging tasks in R&D

Pre-crushing and homogenizing: Two steps in one, and no dust at all!

Many mining materials, ores or tailings are hard and challenging to grind, with abrasion playing a significant role in choosing suitable grinders and milling systems. Pre-crushing is best done in Jaw Crushers, available with abrasion-resistant breaking jaws made of zirconium oxide or tungsten carbide. Fine grinding follows for example in Disc Mills, depending on the sample amount and required final particle size. Tackling the requirement of time saving and avoiding dust formation, Retsch's new combination unit, integrating a jaw crusher with a disc mill and a cyclone, is a perfect solution.
About 1000 g of rock samples were crushed in the new combination unit. The initial feed size was 100 mm, and the gap of the Jaw Crusher BB 250 was set to 2 mm. The feed rate was adapted to the fine grinding step in the Disc Mill DM 200. The sample material broke into pieces with larger particles (less than 10 mm) fed to the fine grinding step. The sample was processed in about 15 minutes. The gap of the Disc Mill was set to 200 µm, resulting in around 400 µm particles. To avoid material wear, the Jaw Crusher can be equipped with tungsten carbide jaws or $NiHard_4$, and the Disc Mill with tungsten carbide grinding discs. For demonstration purposes, the intermediate fraction is also shown below. Thanks to the cyclone, formation of dust pollution in the air is prevented – thus assuring healthier working conditions. The air stream generated also helps to discharge the ground material and dusty fraction completely from the machine which leads to almost 100 % sample recovery.

Original sample

Intermediate fraction

Final result

Homogeneity test: perfect homogeneity after grinding in Vibratory Disc Mill RS 200

Modern XRF instruments with sophisticated software deliver precise and reproducible results quickly. Instrument errors are negligible, so accuracy depends on calibration and sample preparation. Particle size knowledge is crucial as it strongly influences results. Representative and homogeneous samples eliminate potential errors. Mechanical sample preparation usually takes most of the analytical time and will be discussed in this report. For XRF analysis, a few grams of the laboratory sample often represent several tons. Reliable sample preparation is often neglected, leading to insufficient reproducibility and incorrect results. The quality of the spectrometer and sample preparation process decisively influences precision and reproducibility. Elements with small atomic numbers are harder to detect in XRF analysis, affecting reproducibility. A fineness of at least 80 µm is required, e.g., for dolomite, to ensure reliable results when analyzing elements lighter than potassium.
The degree of homogenization of the RS 200 can be shown easily. 118.75 g quartz and 6.25 g tantalum pentoxide (Ta_2O_5) were milled for 1 min at 1,500 rpm in a 250 ml grinding set of hardened steel. A fineness of D97 = 100 µm was achieved. Samples were then taken from various locations in the grinding jar, one at 120°, one at 240° and one at 360° with different depths (surface, center and bottom). The pulverized samples were then mixed with Licowax® and pressed in 40 mm aluminum cups with the Pellet Press PP 40. The

pellets were analyzed using the Spectro Xepos P spectrometer. The main focus was on the concentration of Tantalum in the pellets taken from the different locations in the grinding jar. To represent the original quartz-tantalum mixture each pellet should contain 41 mg Ta per g. All samples showed values very close to this calculated value. Very good homogeneity was observed, all samples showed comparable negligible variations of the tantalum content, independent of the location of sampling or the mill used (table 1). The relative standard deviation with a maximum of ±0.54 mg/g was very low.

High Energy Ball Mill Emax

Transforming waste secondary sulphide materials into high-value components for tellurium-free thermoelectric devices

Mine wastes are byproducts of ore extraction and processing, consisting of finely ground rock particles, water, and residual chemicals. Proper management and disposal are crucial to prevent soil and water contamination, which can cause significant ecological damage. Effective recycling and reuse strategies are essential to mitigate environmental risks and promote the valorisation of secondary mineral resources in Europe. The Horizon Europe START project* transforms waste secondary sulphide materials into high-value components for tellurium-free thermoelectric devices, contributing to sustainable industrial processes. Innovative approaches to tailings management, including new waste treatment technologies and stricter environmental regulations, can further reduce the negative impacts of copper mining. On a laboratory scale, the powders are produced at Laboratório Nacional de Energia e Geologia (LNEG) : facilities using the Retsch High Energy Ball Mill Emax. The unique characteristics of Emax, and in particular the high levels of mechanical energy input, allow the reactivity of the powders to be changed so that the direct synthesis of nanostructured mineral-derived tetrahedrite powders occurs near room temperature.

Conclusion

In conclusion, optimizing mineral analysis requires addressing sample preparation challenges, ensuring homogeneity, and considering health and time-saving aspects. Proper sample preparation is crucial for accurate results, as contamination and particle size can significantly impact the analysis. Innovative solutions, such as Retsch's combination unit, help tackle these challenges by integrating pre-crushing and fine grinding steps while preventing dust formation. Additionally, recycling mine wastes through projects like the Horizon Europe START project promote sustainable practices and reduces environmental impacts. By transforming waste materials into valuable components, the mining industry can contribute to more efficient and eco-friendly processes. Retsch instruments enable the different aspects of mining applications efficiently.

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