PROCONM
TRANSPORTE LIMPIO

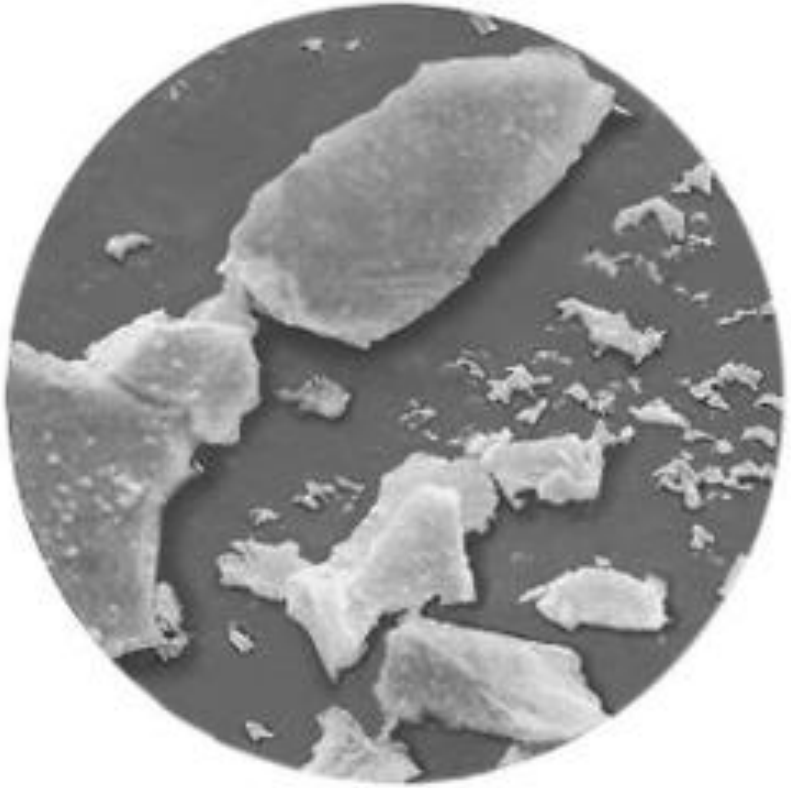
Specialization Course in Dust and Spill Control

Class 02: Silicosis, PPE (Nasal Protection), and Control of the Silicogenic Environment

Respirable Crystalline Silica (Silica)

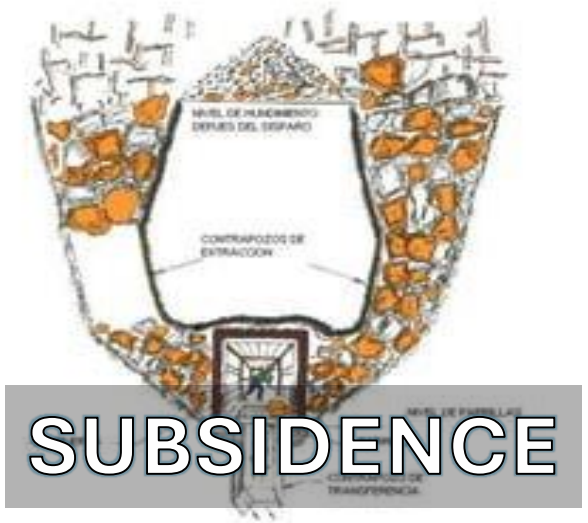
Respirable Crystalline Silica is the respirable fraction, PM5 or PM4 according to NIOSH, of crystalline silica or silicon dioxide (SiO_2), a highly abundant mineral in nature.

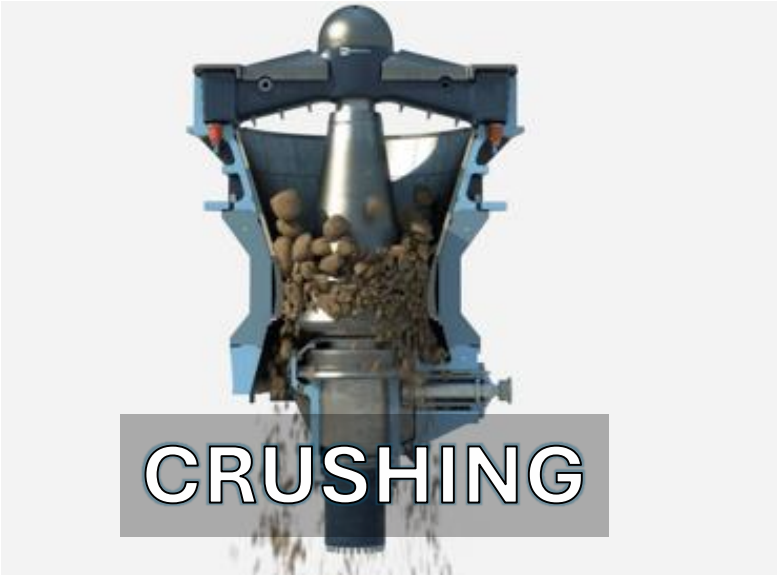
Silica is not found on the ground; it is released during cutting, polishing, crushing, fracturing processes, etc. [12]



Microscopic Image of Silica
Image Source: CDC-NIOSH

Processes that Release Silica in Mining

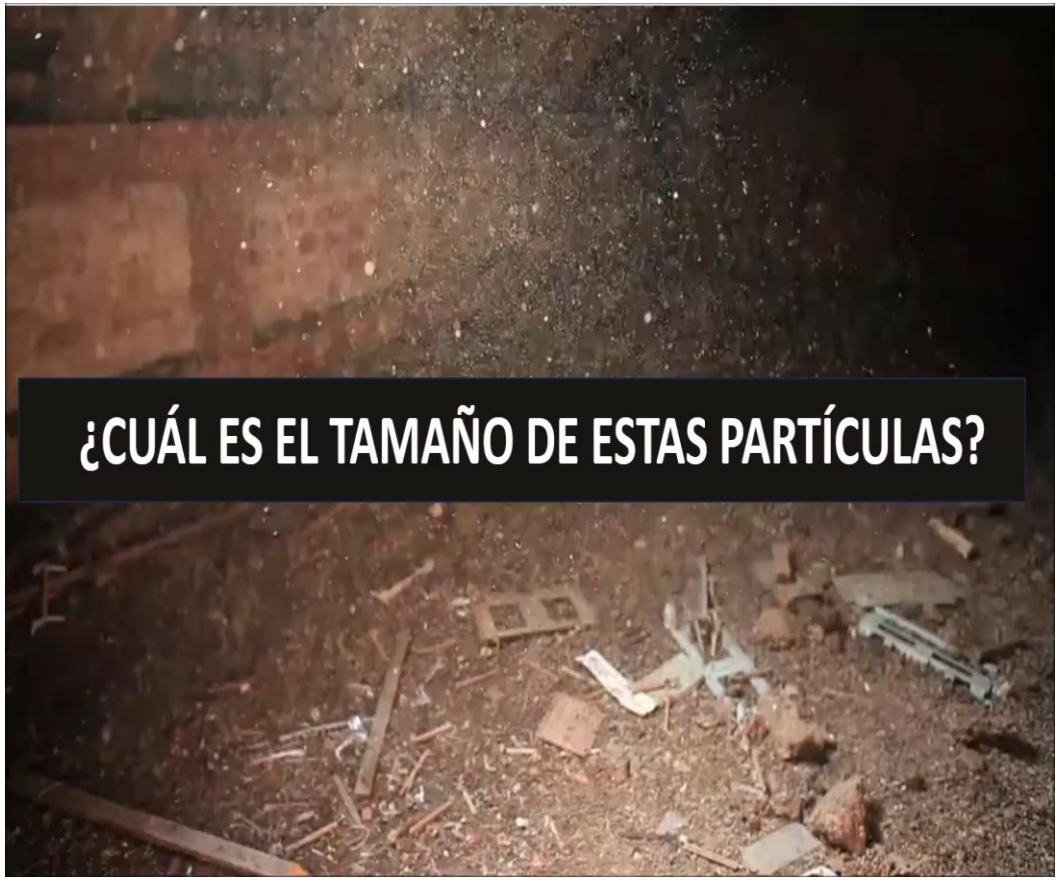




PM5 particle suspension

The terminal velocity of the maximum size of PM5, which is 5 microns, is 0.007 m/s (0.025 km/h). Therefore:

- Outdoors, it is impossible for it to settle.
- Indoors, it remains in suspension.

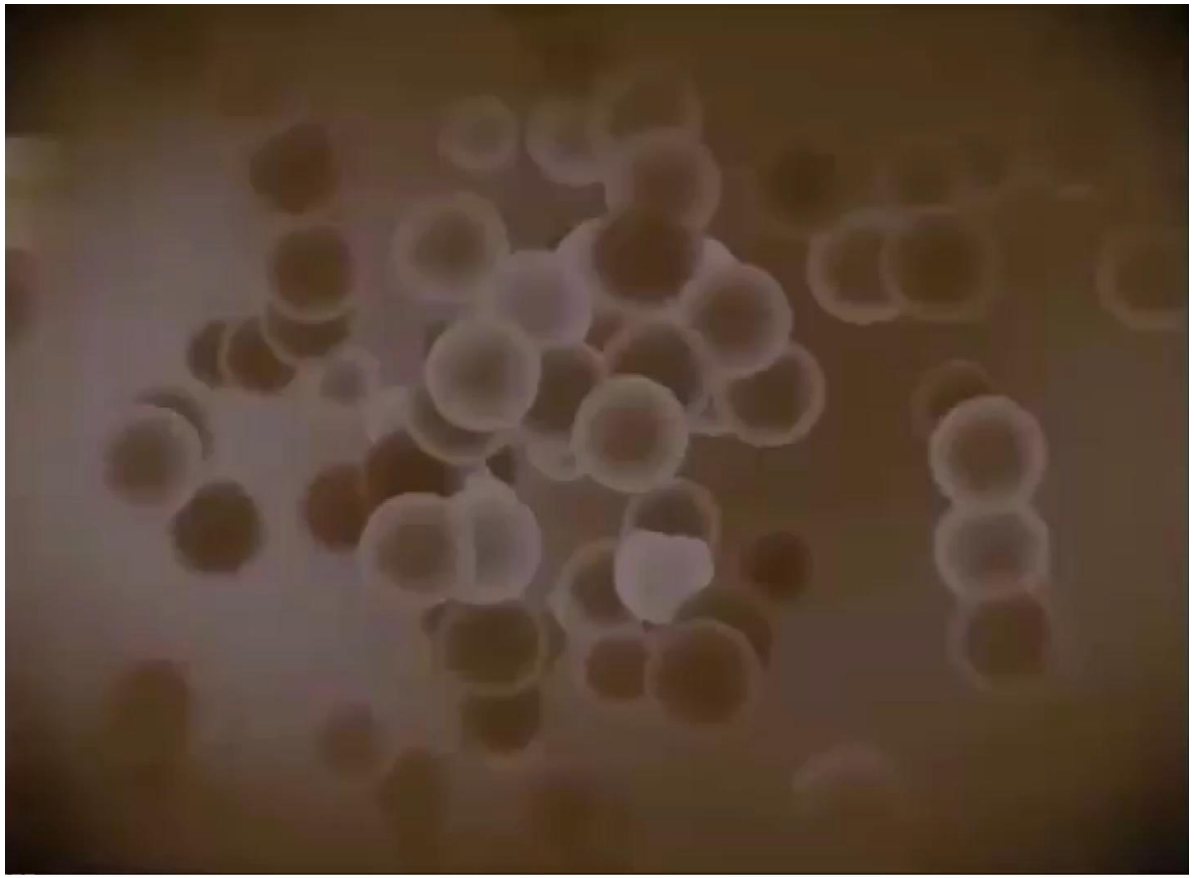


A silicogenic environment is one that in its respirable fraction (PM5) contains 1% or more silica. In this environment, there is a risk of acquiring the following diseases:

- Silicosis
- Lung cancer
- Chronic Obstructive Pulmonary Disease (COPD)
- Bronchitis and emphysema
- Tuberculosis or exacerbate this disease
- Increases the risk of kidney and autoimmune diseases.

Silicosis

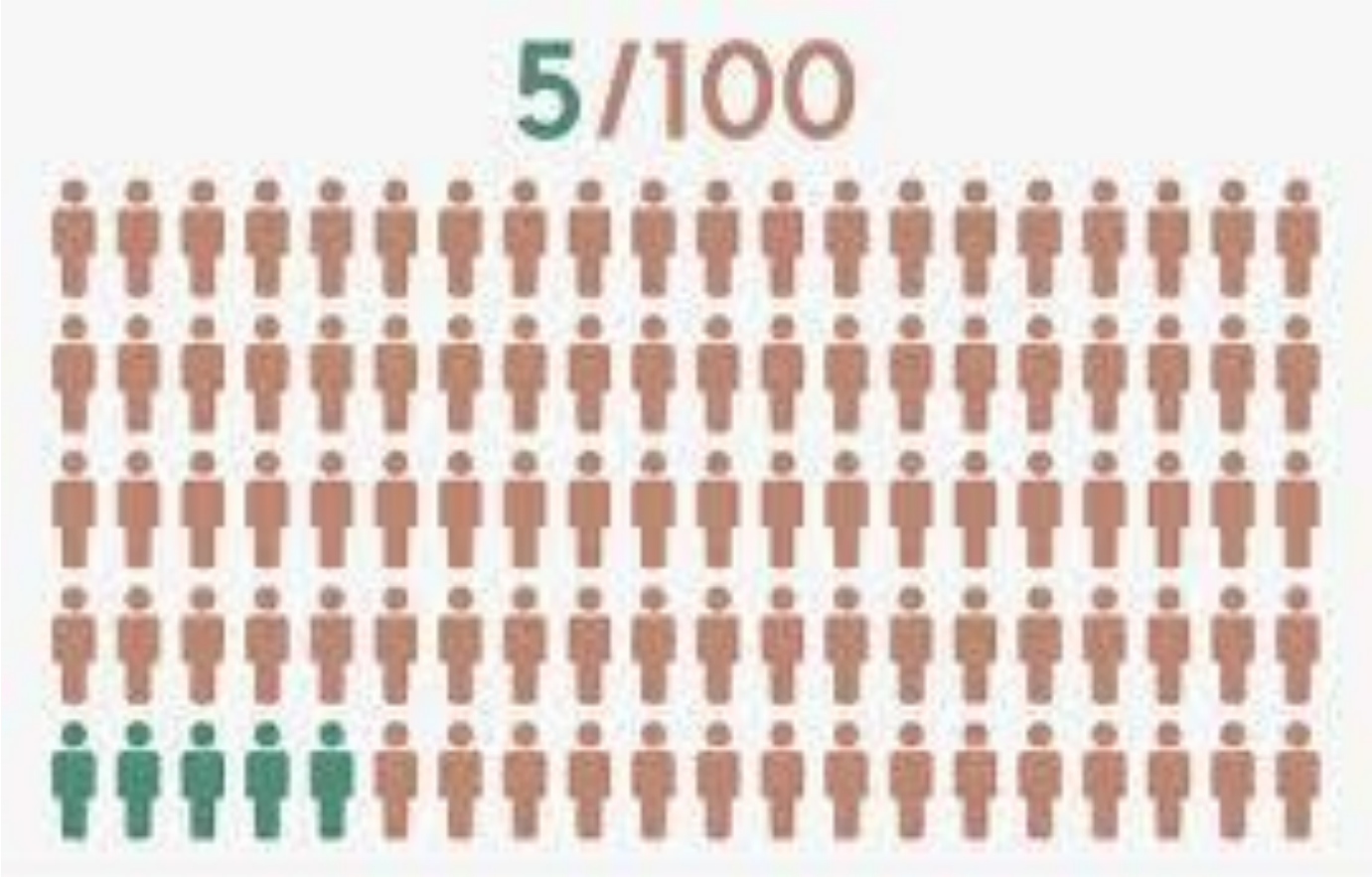
Silicosis is a fibrotic lung disease, a pneumoconiosis, of irreversible and progressive nature, considered a disabling occupational disease, acquired in a silicogenic environment. [12]



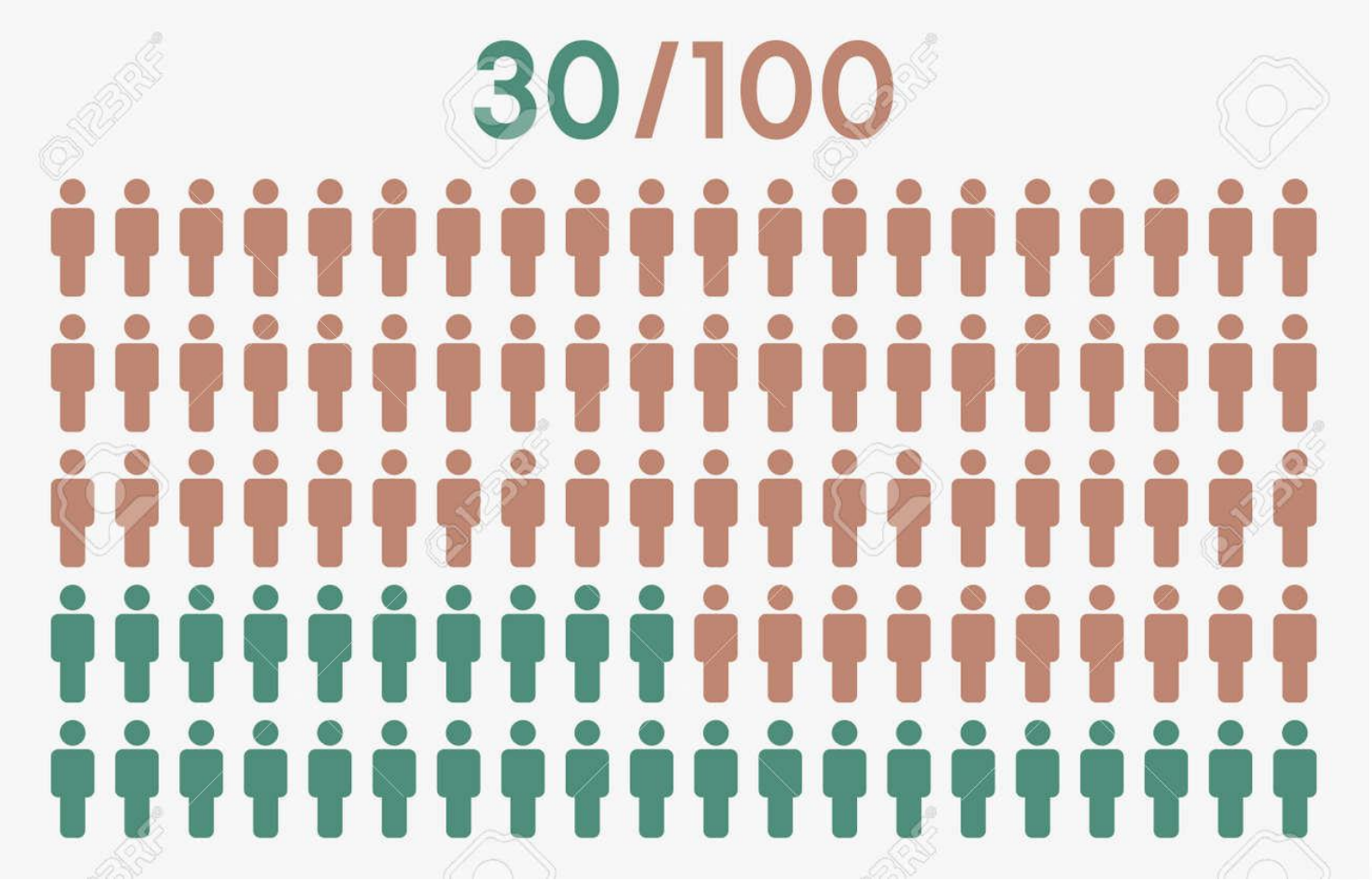
The **REL** (Recommended Exposure Limit) is the exposure limit recommended for a substance in the workplace, established by NIOSH, which is based on a time-weighted average for up to 10 hours per day during a 40-hour workweek. For quartz silica, the REL is 50 µg/m³. [7]

In Chile, the Permissible Weighted Limit (PWL) for crystalline silica is 80 µg/m³ for quartz and 40 µg/m³ for tridymite. [3]

According to OSHA [7], exposure to 50 μg/m³ (which corresponds to the REL) over a period of 45 years causes silicosis in 5 out of every 100 people.



While exposure to twice the level of silica (100 µg/m³) increases the risk to 30 out of every 100 people



Study on Silica Exposure [14]

- The objective of the study was to investigate the risk of silicosis among tin miners in China and the relationship between silicosis and cumulative silica exposure.

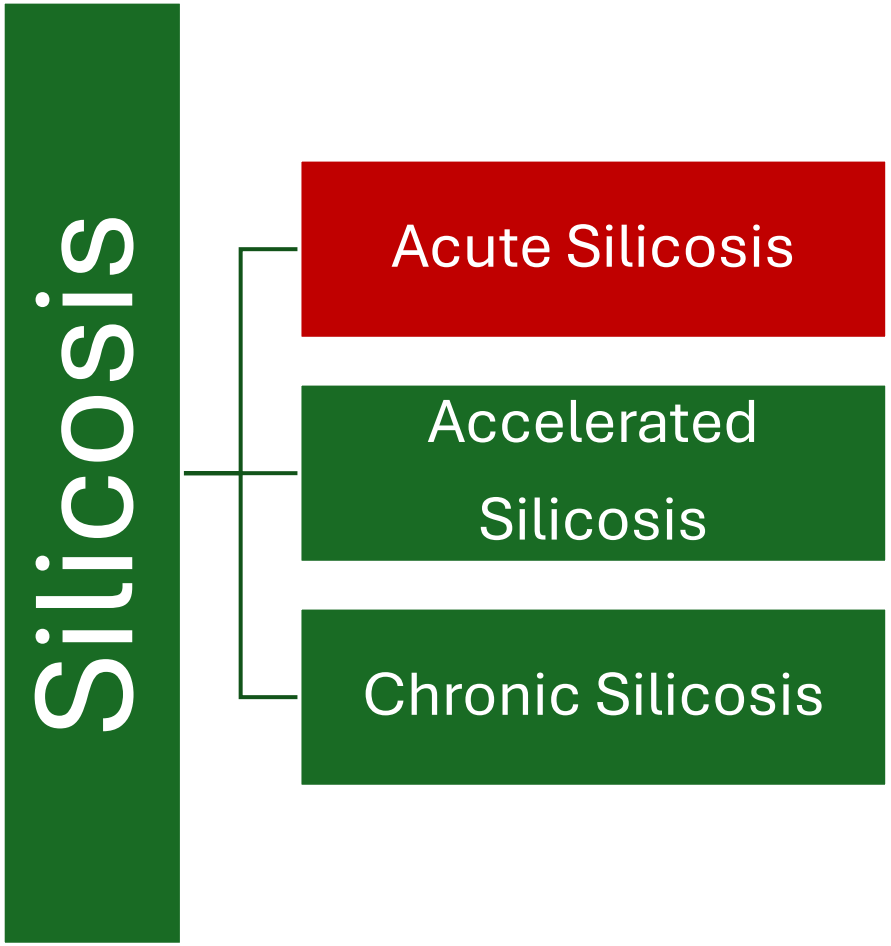
- A study was conducted with 3,010 miners who worked in four tin mines in China between 1960 and 1965. Historical data on total dust were used to create a job exposure matrix.

- Total dust exposures were converted into estimates of silica exposure. Each worker was followed until the diagnosis of silicosis, based on the 1986 Chinese pneumoconiosis diagnostic criteria.

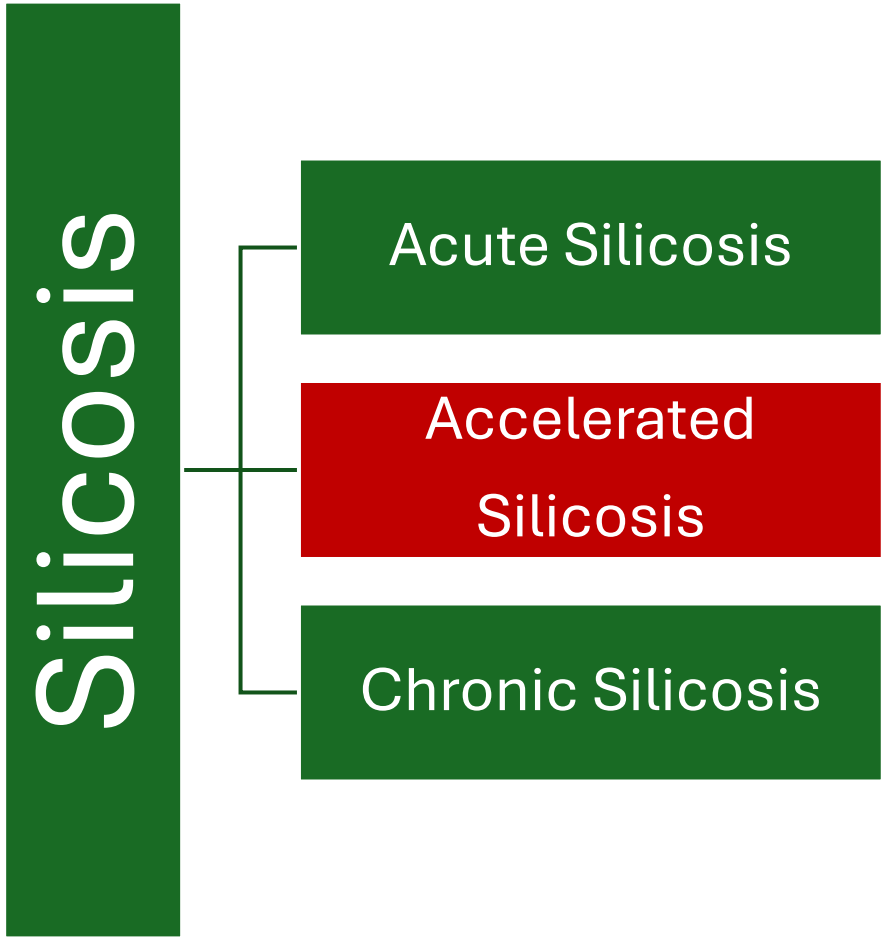
Study Results: Concentration vs Risk

Cumulative Total Dust Concentration (CTD) (mg/m^3-years)	Silicosis Risk (%)
<10	<0.1
10-19	1
20-39	7
40-59	15
60-79	29
80-99	41
100-149	66
>150	92

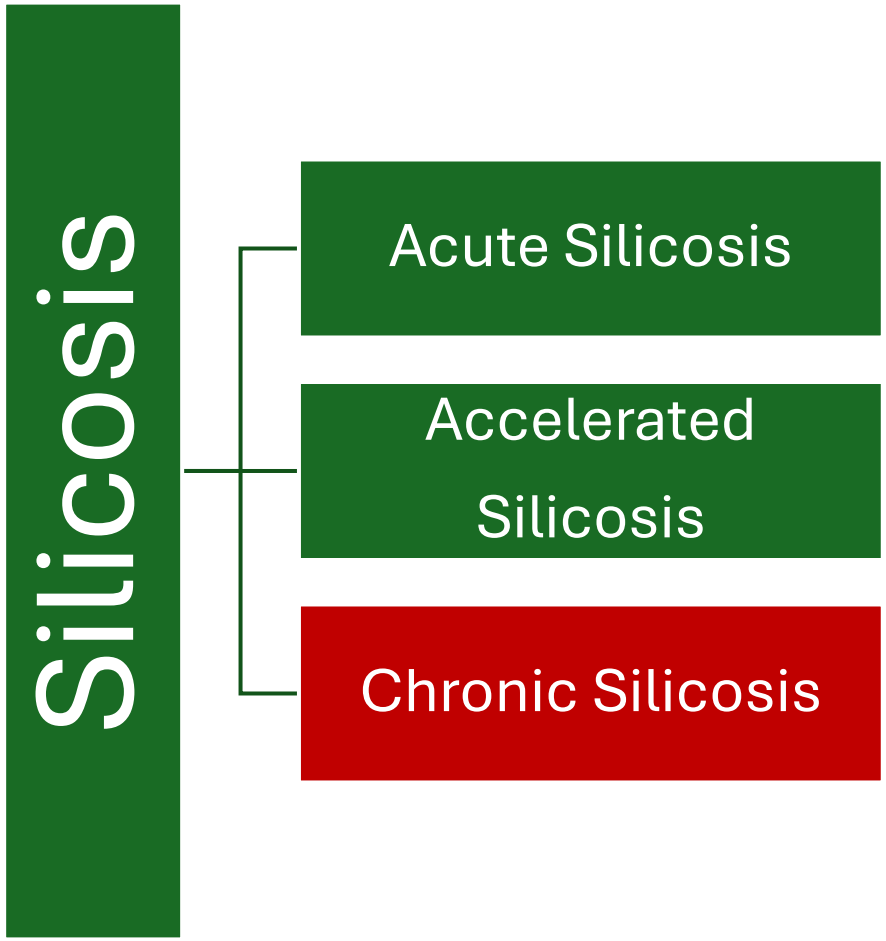
According to exposure time and silica concentration, there are the following types of silicosis:



Acute Silicosis: It occurs when exposure concentrations are at their highest levels and can cause symptoms within a few weeks to 4 or 5 years after the initial exposure



Accelerated silicosis. It results from exposure to high concentrations of crystalline silica and develops 5 to 10 years after the initial exposure



Chronic silicosis. Typically occurs after 10 or more years of exposure to crystalline silica at relatively low concentrations.

GPES y PNES [8]

National Programs for the Elimination of Silicosis (PNES) were established within the framework of the Global Program for the Elimination of Silicosis (GPES) by ILO/WHO. Countries are required to develop a national plan.

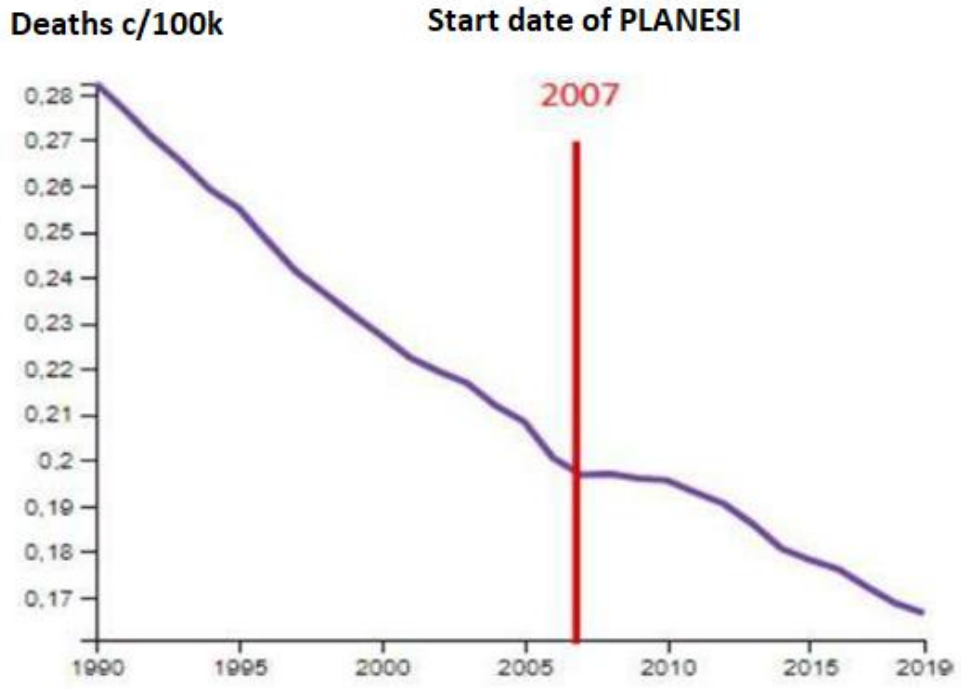
World Health Organization

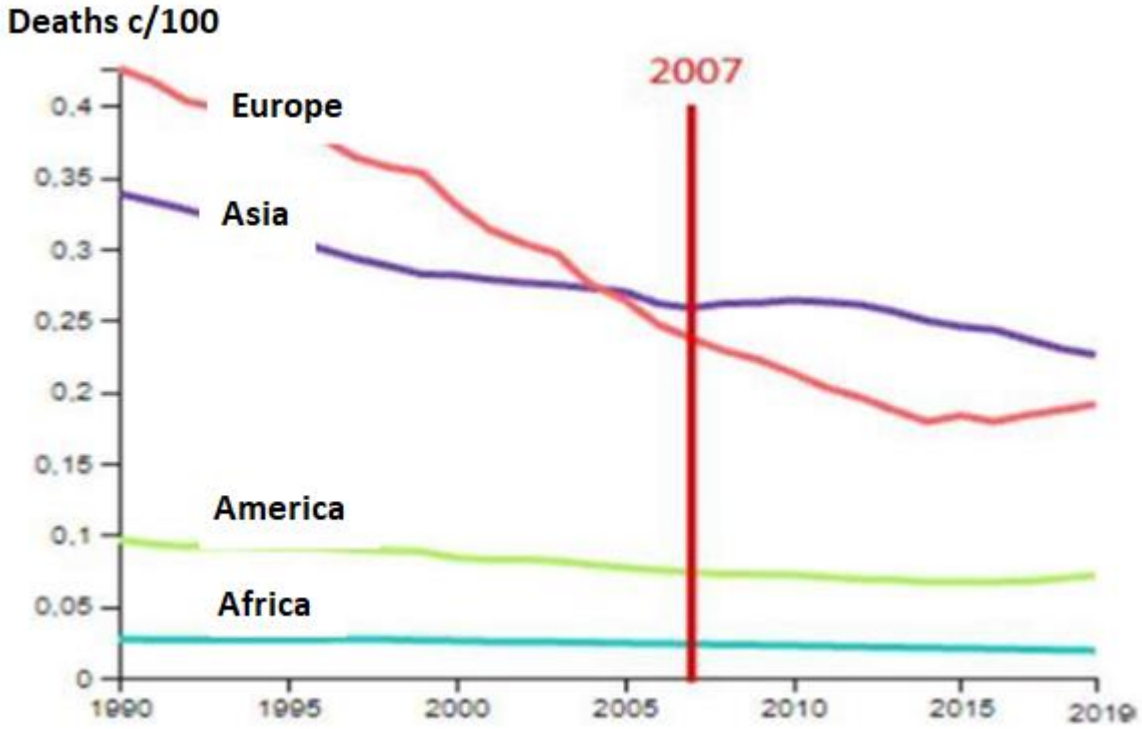
Committed Countries

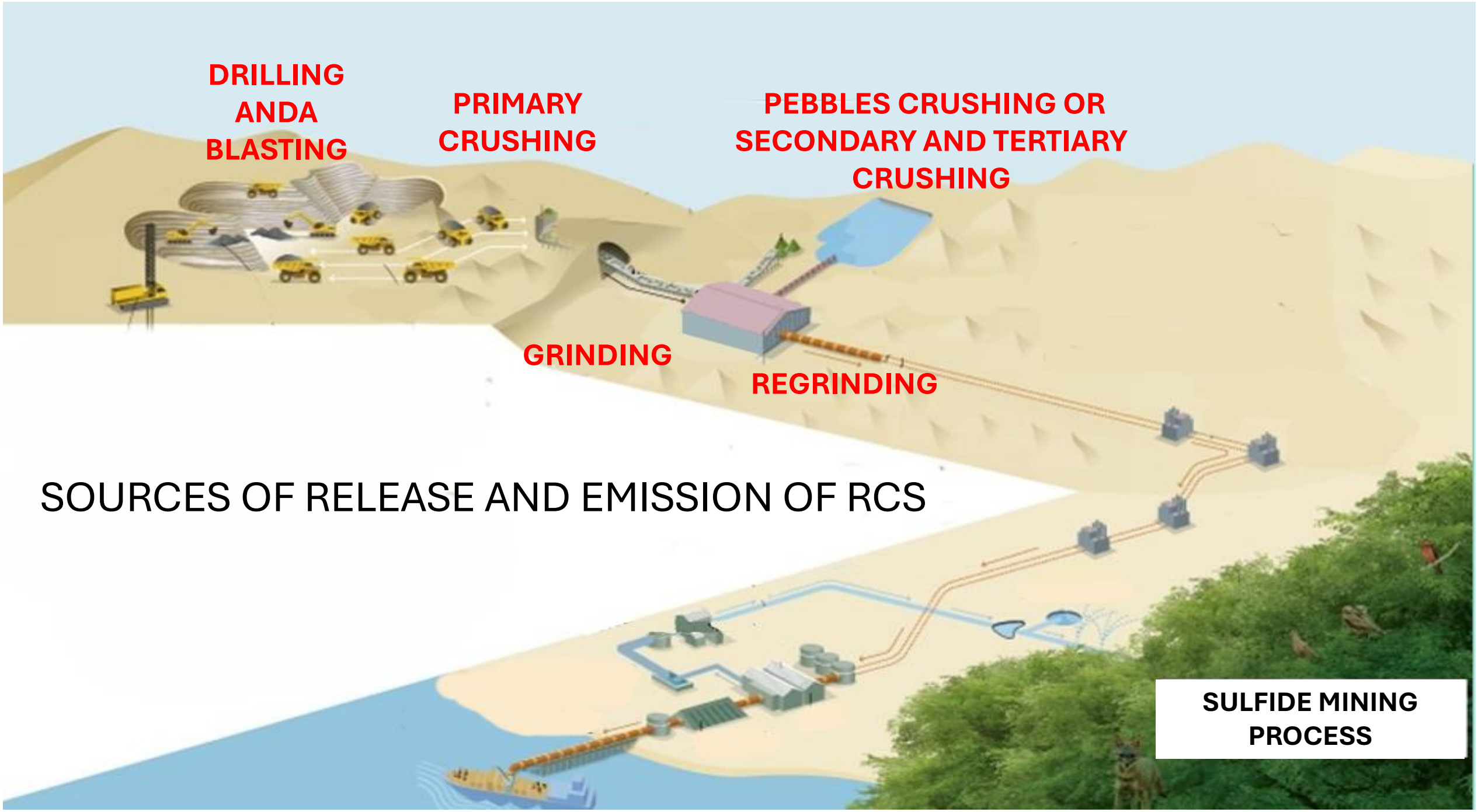
o date, National Programs for the Elimination of Silicosis (PNES) have only been established in 9 countries: Brazil, Chile [9], China, India, Peru [10], South Africa, Thailand, Turkey, and Vietnam.

PLANESI [11]

Deaths from silicosis worldwide have decreased. However, in the Americas and Africa, they have remained constant. In other words, no progress has been made in the commitment to eradicate silicosis by 2030 on these two continents, which have consumed over 70% of the allotted time with just 7 years remaining until the target date

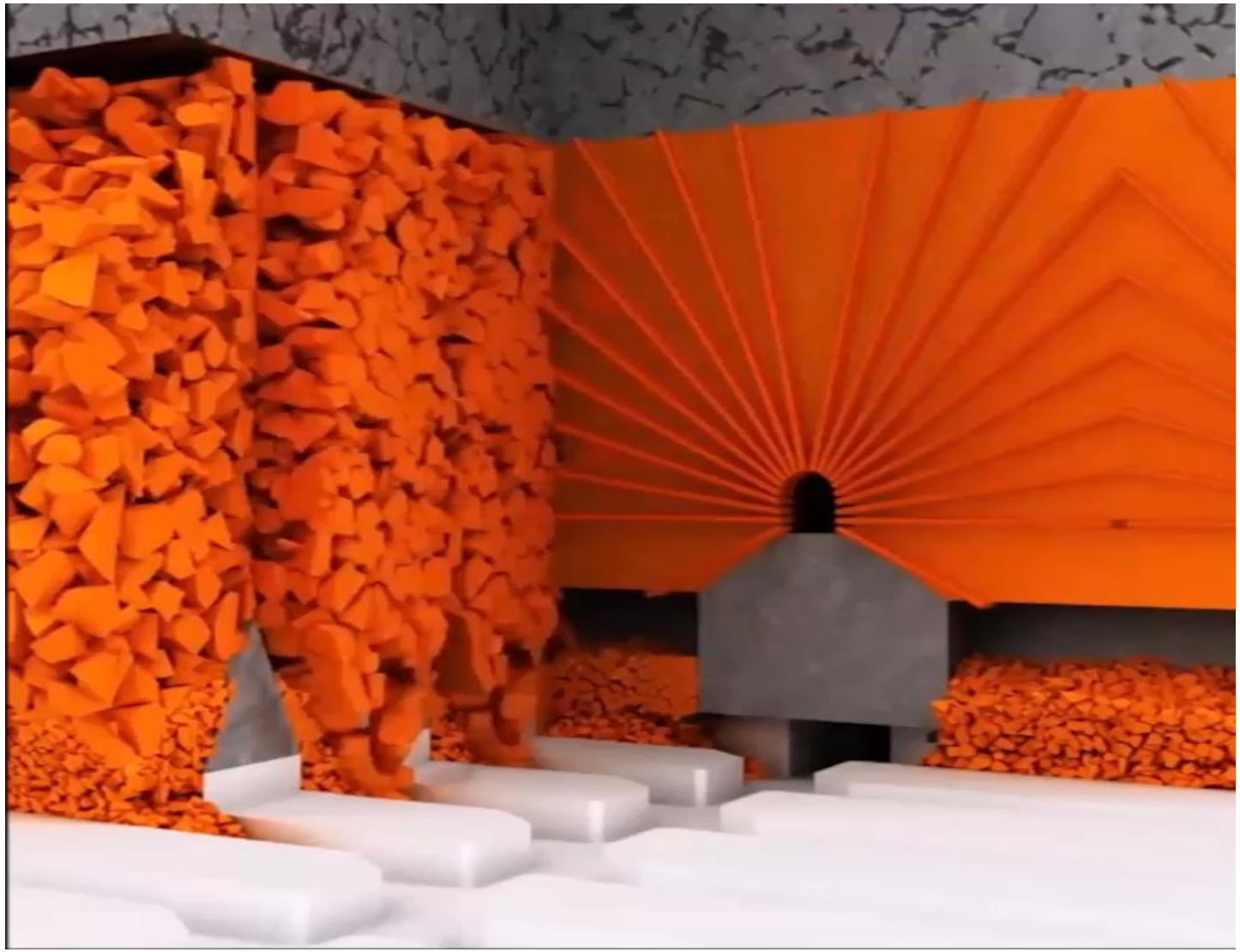




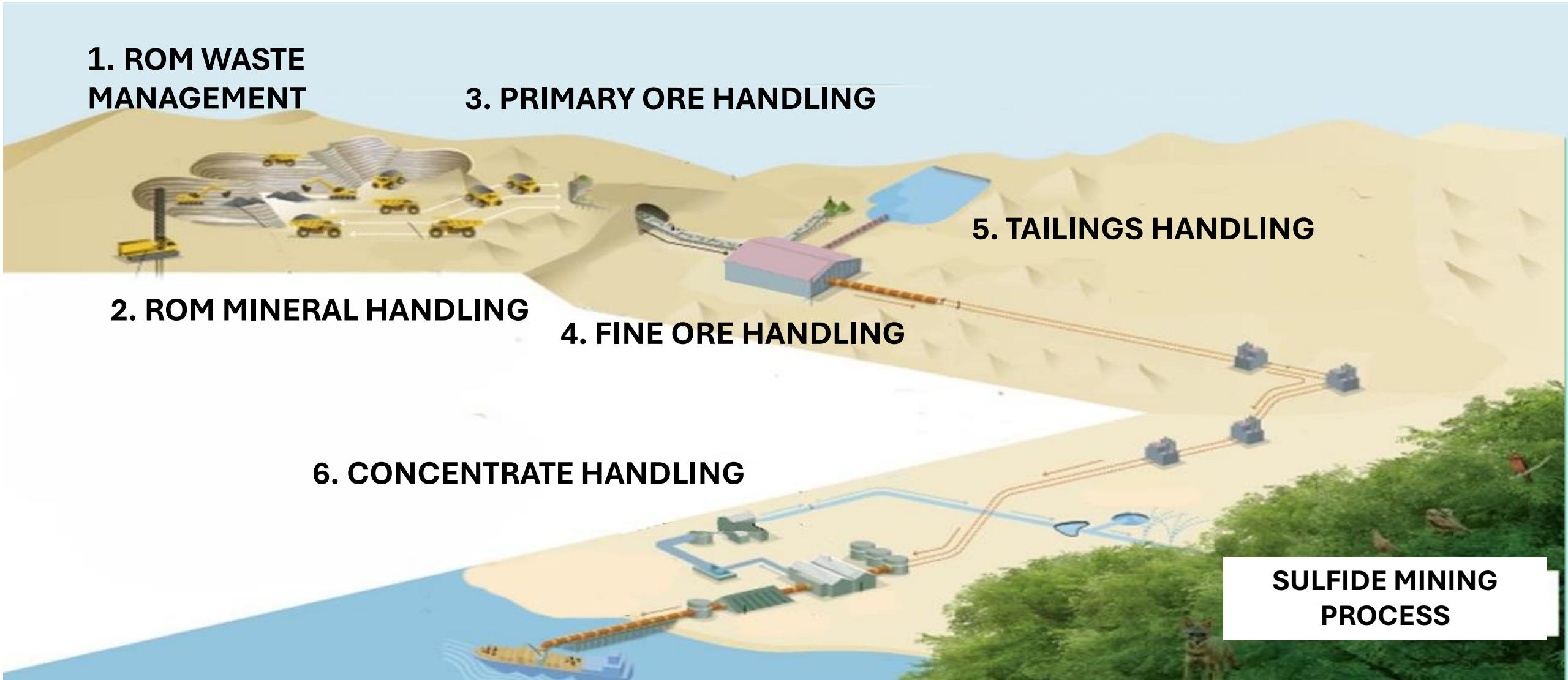

DRILLING
ANDA
BLASTING
PRIMARY
CRUSHING
PEBBLES CRUSHING OR
SECONDARY AND TERTIARY
CRUSHING
GRINDING
REGRINDING
SOURCES OF RELEASE AND EMISSION OF RCS
SULFIDE MINING
PROCESS

Main source of silica release in open-pit mining: blasting

Main source of silica release in underground mining: rock falls



All areas of a mining plant have the presence of silica. Therefore, they have the potential to contaminate to varying degrees. The actual situation and measurements provide the following order of precedence



Watering

Watering is useful for controlling settleable or larger particles. That is, it is temporarily effective for visible dust.

PM5 does not settle and is not found on the ground. Consequently, watering has no effect on controlling silica.

Suppression or Abatement: Dry Fog

Dry fog acts on an average droplet size of 10 microns. Therefore, it has minimal impact on PM5. As a result, it is not an effective control for silica.

Surface Moistening, Local Control

Although water does not wet PM5, moistening the dumps or the coarse mineral located on the surface helps increase the cohesion of the fines on the dumps, including PM5.

This is a local control measure, as PM5 remains present and can still migrate downstream.

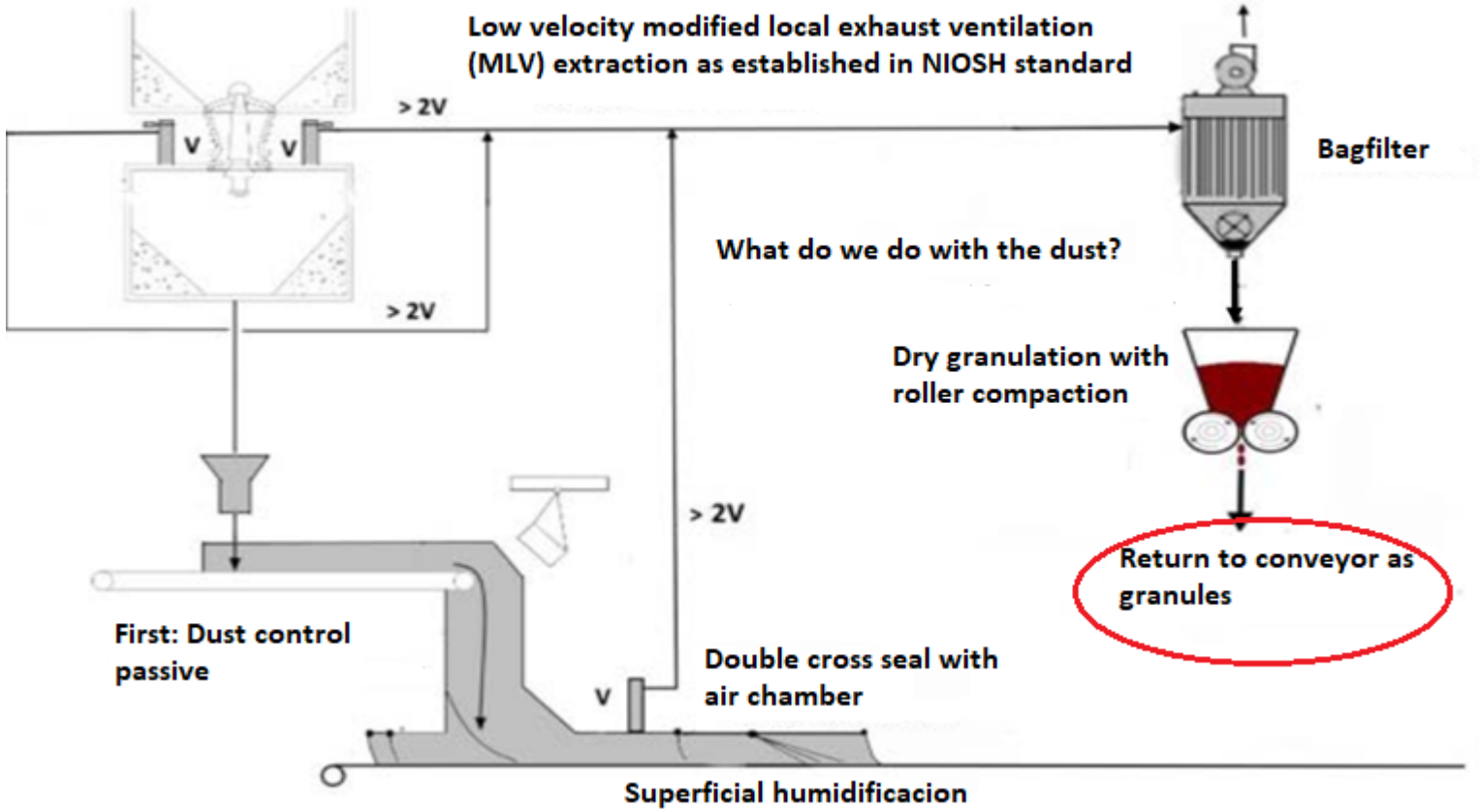
Application of Surfactant: Increases Adhesion

Recirculating Extraction. Local Control

The dry or wet dust extraction system with recirculation can have a positive impact on controlling visible dust, but minimal impact on controlling silica.

Extraction with Removal

The dust extraction system with recirculation of dust converted into granules or similar, or its removal as slurry is the only effective method to reduce silica on-site and downstream. In other words, its definitive removal.



Nasal Protection

According to NIOSH standards, do not use nasal protection as the primary means to avoid exposure to airborne contaminants. Instead, eliminate the sources that generate the contaminants and maintain continuous monitoring. The following recommendations are based on NIOSH standards, the 3M provider, and our research.

Cabin Protection

According to ISP (Chile), the shovel operator is exposed to a concentration of 25 times the PEL, and the crushing plant operator is exposed to 16 times the PEL [13].

According to NIOSH standards, equipment operators must be in a pressurized cabin free of silica. The intake air should be filtered through a filter with 95% efficiency in the range of 0.3 to 10.0 micrometers [7].

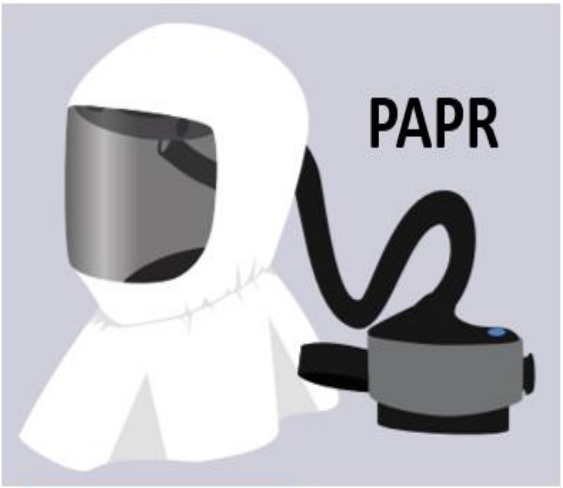
Nasal Protection

- **≤ 5 REL or PWL**. Any half-mask air-purifying respirator with a high-efficiency particulate filter.

- **≤ 10 REL or PWL**. Any full-face air-purifying respirator with a high-efficiency particulate filter.

- ❑ **≤ 25 REL or PWL**. Any mechanical air-purifying respirator (loose-fitting PAPR) with PAPR, or any air-supplied respirator equipped with a hood and helmet and operated in continuous flow mode.

- ❑ **≤ 50 REL or PWL**. Any air-purifying respirator, full-face mask with PAPR, or any mechanical air-purifying respirator (PAPR with a tight-fitting seal), and PAPR



Clothing

Silica has been measured in offices and cafeterias. Significant levels of silica have been detected in these areas. It is most likely that work clothing is the source.

- According to NIOSH, workers should change into clean clothes before entering cafeterias or offices.

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[6] 40 CFR Part 50, Review of the National Ambient Air Quality Standards for Particulate Matter. Environmental Protection Agency (EPA), USA

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¡End of Class 02!

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