Lead

Where does it come from? How is it used in Mining?
Lead is a very soft, heavy, blue grey metal that can be associated with underground mining. The most common lead minerals are galena (lead sulfide), anglesite (lead sulfate), and cerussite (lead carbonate). Lead can also be found in: mimetite, pyromorphite, schultanite, cottunite, plattnerite, wulfenite, lanarkite, altaite, mineral red, or Paris red. In addition, lead is of often a by-product or co-product at zinc, copper and/or silver mines. Lead is also an end-product of the radioactive decay of uranium.

What are the primary health effects from exposure to Lead?
According to OSHA, over-exposure to lead is the most common cause of workplace illness. During the mining process small particles containing lead can be inhaled or they can settle on the skin. Long-term inhalation or ingestion of lead-containing particles can cause severe damage to the blood-forming, nervous, urinary or reproductive systems. Short-term exposures to very high levels of lead can cause: loss of appetite, nausea, vomiting, stomach cramps, constipation, difficulty in sleeping, fatigue, moodiness, headache, joint or muscle aches, anemia, decreased sexual drive and even death.

What are the occupational exposure limits for Lead?
Title 30 CFR §§ 57.5005 states that exposure shall not exceed the Threshold Limit Values Adopted by the American Conference of Governmental Industrial Hygienists in 1973. The Threshold Limit Values for lead are 0.15 mg/m^3 (150 $\mu g/m^3$) and 0.45 mg/m^3 (450 $\mu g/m^3$) averaged over 8 hours and 5 minutes, respectively. While not required by the Mining Safety and Health Administration, it is highly recommended to comply with the most current recommended airborne concentration standards. The 2011 ACGIH TLV for inorganic compounds of lead is 0.05 mg/m^3 for an 8-hour time-weighted average.

How often should I complete exposure monitoring for Lead?
30 CFR Part 56.5002 requires that dust, mist, and fume surveys be conducted *as frequently as necessary* to determine the adequacy of control measures. It is standard practice to sample initially (called a baseline evaluation) to determine potential exposure concentrations. Routine or periodic monitoring (usually annually) is also recommended. Sampling may need to be done more often if the tasks change, if engineering controls change, or if sampling results are above the "action limit" which, for most chemicals, is defined as 50% (or half) of the TLV.

How do I measure potential exposures to Lead?
To assess lead exposures you should conduct both air sampling and wipe sampling. Air sampling can be completed for the entire shift to compare with the 8-hr limit or for 15 minutes to compare with the short-term exposure limit. Consecutive short-term exposures could be completed to obtain the time-weighted full shift exposure.

A sampling pump is calibrated to 1.7 liter per minute. A 37 mm diameter mixed cellulose ester (MCE) filter with a 0.8 µm pore size is placed in a cassette and connected to the pump. The pump is placed on the worker with the cassette in their breathing zone for the appropriate duration. Upon completion the filter should be set to certified laboratory for analysis. The laboratory should use analytical method MSHA P-3. At least one blank filter should also be sent. This filter should go through all the same processes except that the pump is not turned on.

Once the laboratory provides you with the mass of lead measured on the filter, you can calculate the air concentration as:

$$C = \frac{M}{Q \times T}$$

where C is the concentration of lead in mg/m^3, M is the mass of lead measured on the filter in mg, Q is the pump flow rate in liters per minute and T is the total time of sampling in minutes. Note that many laboratories will loan you the necessary equipment to obtain the samples and provide you with the appropriate filters.

Wipes samples should be completed while wearing clean disposable gloves to avoid contamination. A piece of Whatman filter paper (41 or 42) or smear tabs moistened with distilled water is used to wipe a 10 cm x 10 cm area. Then the paper is folded in half and transported in a plastic bag or jar to the laboratory for analysis. An unused piece of filter paper should be submitted to the laboratory as a blank.

Certified laboratories that can assist with measuring Lead:
Galson http://www.galsonlabs.com/
Analytics Corporation http://www.analyticscorp.com/

How do I control Lead exposures?
Ventilation is recommended for controlling dust exposures including for lead. Appropriate administrative controls should also be used to ensure adequate maintenance for the ventilation system. Housekeeping policies should also be developed and used for further dust suppression and surface decontamination. It is recommended that an appropriate NIOSH approved respirator be used at exposures less than the following concentrations.

Concentration (mg/m^3)	APF	Respirator
0.5	10	air-purifying with a HEPA filter or supplied-air
1.25	25	supplied-air operated in continuous-flow mode or powered air-purifying with a HEPA filter
2.5	50	air-purifying full-face piece with a HEPA filter, supplied-air with tight-fitting face piece operated in continuous-flow mode, powered air-purifying with tight-fitting face piece and a HEPA filter, self-contained breathing apparatus with full face piece, or supplied-air with full face piece
50	1000	supplied-air operated in a pressure-demand or other positive-pressure mode
1000	2000	supplied-air with full face piece operated in a pressure-demand or other positive-pressure mode

References:
MSHA. 2007. Metal Nonmetal Health Inspection Procedures Handbook. PH06-IV-1(1). http://www.msha.gov/readroom/handbook/PH09-IV-1.pdf
MSHA Code of Federal Regulations (http://www.msha.gov/30cfr/0.0.htm).
Mineral Information Institute. Common Minerals and Their Uses. http://www.mii.org/commonminerals.html
Patnaik, P. 2007. A comprehensive guide to the hazardous properties of chemical substances. New Jersey: Wiley & Sons.
OSHA Safety and Health Topics: Lead. http://www.osha.gov/SLTC/lead/