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APP I

FINAL REPORT FACT SHEET

USDOI Office of Surface Mining Reclamation and Enforcement

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CO2 Flux field delineation for construction on reclaimed mine land

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Project Description and Objectives:

Elevated concentrations of CO2 have been found in homes built on reclaimed mine land and land adjacent to active mines. This has been attributed to neutralization reactions between acid mine drainage (AMD) and alkaline addition in mine spoil. Fast and reliable survey methods are needed to assess reclaimed mine land to determine the extent and intensity of the CO2 flux field. Current forensic approaches are retrospective and cannot be easily implemented as survey techniques over large parcels of land, prior to construction. This project developed a soil CO2 flux (emission rate) survey protocol for assessing reclaimed mine land for construction purposes; and an approach to delineate high CO2 flux fields for making decisions on post-mining land uses.

Applicability to Mining and Reclamation:

A CO2 flux survey protocol for reclaimed mine land has been developed based on the results of this research. Geostatistical procedures for delineating high risk zones based on the results of flux surveys have been outlined. Together, these methods can be used to assess reclaimed mine sites for CO2 intrusion hazards if the land is developed for residential/commercial real estate. These methods are applicable wherever the presence of AMD and carbonate pose the risk of CO2 intrusion.

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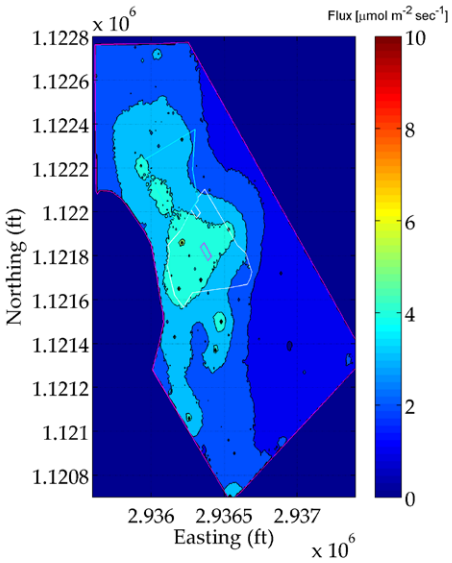
ABOVE PHOTO: Researchers collecting soil gas samples for isotope sampling during flux measurement.



ABOVE FIGURE: Sample flux map. The figure shows the outline of the house surrounded by the lawn area and the barn adjacent to the lawn. The total daily CO2 emission rate for the site (45.7 acres) on this day was 1,844 kg/day.

Methodology:

The study sites were two reclaimed mine sites (one each in Indiana and Pennsylvania) with homes, which have a history of elevated CO2 concentrations attributed to AMD-carbonate reactions. The research involved conducting chamber accumulation flux surveys and stable carbon isotope ratio analysis. The data was then used in statistical hypothesis testing to examine correlation between CO2 flux and soil temperature and moisture as well as spatial dependence. Spatial dependence refers to correlation between the same variable measured at different locations. Finally, researchers used geostatistics to map CO2 fluxes over the property and delineate high flux zones.

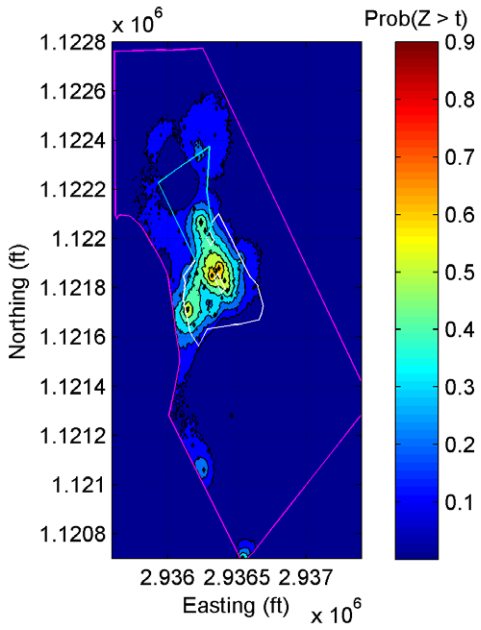
Results/Findings:

- Soil temperature was observed to have a positive, monotonic correlation with fluxes while soil moisture was observed to have a negative, monotonic correlation.
- Data from different days should be treated as separate, since sample day effects are significant.
- Flux samples should be taken at less than 61 m (200 ft) spacing, respecting best practice for chamber accumulation flux measurement.

Highlights:

The results show that spatial variation of CO2 fluxes on reclaimed mine land is not always random with significant spatial dependence observed. Geostatistical methods have been demonstrated to be capable of delineating high flux fields, although, further research is needed to establish thresholds for such analysis.

The research suggests that macro-porosity and gas permeability may be important factors that explain CO2 migration in mine spoil. Low soil-atmosphere CO2 exchange, under normal circumstances, was observed even though CO2 concentrations at depth in the spoil were high (up to 17.6%). Surface CO2 carbon isotopic composition indicates very little upward migration, under normal diffusive fluxes. Parts of the property disturbed by construction activities appear to have the higher fluxes. This can lead to misleading conclusions from isotope ratio results if soil gas samples are not acquired from depth.



ABOVE FIGURE: Sample CO2 hazard delineation. Hazard measured as probability of exceeding set flux threshold value.

Website Information:

The final project report can be found at:
http://www.techtransfer.osmre.gov/NTTMainSite/appliedscience/2009/Projects/MSTAwuah-OffeiCO2Flux2009FR.pdf

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