Naturally Occurring Asbestos in Alaska and Experiences and Policy of Other States Regarding its Use

**A joint project
By
Dr. Robert A. Perkins, PE
Institute of Northern Engineering
University of Alaska Fairbanks
And
John Hargesheimer, PE, CIH
Aaron Winterfeld, CHMM
Nortech**

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Institute of Northern Engineering

**University of Alaska Fairbanks
Fairbanks, Alaska 99775
www.uaf.edu/ine /**

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Front cover photo: Asbestos at material site MS 105 on the Dalton Highway

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EXECUTIVE SUMMARY

Naturally Occurring Asbestos (NOA) occurs in mineral deposits in Alaska. Some localities in Alaska do not have gravel sources that are NOA-free, which impacts the cost of heavy construction projects such as roads and airports. Because airborne asbestos fibers are a significant human health risk, mining and industrial use of asbestos is rare in the United States. Disposition of existing asbestos materials in industry and buildings is tightly regulated by federal and state authorities. The use of NOA is not regulated by federal agencies or most states. Determining if NOA can be safely used in heavy construction materials and what can or should be done with NOA materials that are already in place are complex questions. The ultimate answer depends on propensity for the NOA in each scenario to actually release asbestos fibers that may be inhaled by humans, which in turn depends on the amount and type of asbestos mineral, how it is handled in processing, and how it is maintained. Practical analysis of this depends on laboratory analysis, as well as regulation or control of operations. Implementation of these requires stakeholder education and cooperation and agency oversight. This report summarizes these from the perspective of the Alaska Department of Transportation (ADOT).

Some key points:

- NOA is present in many states, but only a few have regulations governing its use.
- There are many regions in Alaska that have minerals in surface rocks that may contain asbestos and asbestos has been discovered in many locations in Alaska.
- Gravel is constantly in demand for heavy construction projects, if a major project, such as the gas pipeline is built, it will require very large quantities of gravel
- All future material site exploration should consider the possibility of encountering NOA, and those areas indicated by mapping as possible NOA minerals should be carefully investigated.
- California, which does have NOA regulations, uses a threshold asbestos concentration, below which the material is not considered NOA. If the material is NOA, regulations cover its use. Virginia is similar.
- Starting with a site-specific plan and then covering the material and reducing dust are key features of those regulations, if NOA is over the threshold asbestos content.
- We present a review of dust suppression and capping techniques, many of which might be useful, depending on the situation.
- Education of the public and worker training are important components of any NOA plan.

The key conclusion is that NOA can be used in many projects, but precautions are needed, especially a plan for its use. Considering the importance of NOA to ADOT's mission we recommend that the ADOT take the lead in a statewide effort to develop an appropriate NOA policy and program by coordinating a stakeholders working group effort. NOA programs in other states were developed with input from industry, public health, environmental and state organizations and agencies. The outputs of the NOA programs included source characterization, geologic mapping, standardized operating procedures (SOP), program exemption procedures, and local authority. Successful implementation of a NOA program will require significant commitment and change in industry, operational, management, design and construction practices for use of NOA materials. To insure comprehensive input and facilitate stakeholder "buy in," the statewide working group should include federal and state, and local government, as well as industry, community and public health interested parties.

Here we assume that in order for projects that must use NOA to proceed, the ADOT must have a standard or SOP that contains the goals and guidelines that the ADOT must follow in order to use NOA safely. The SOP in turn would require a specific action plan for each project. Of course other project owners could use the ADOT's SOP. Thus, the ADOT's goal with the NOA working group is to develop an SOP that is directed towards ADOT projects, but also satisfies the goals the various stakeholders. We note here that protecting the public health and safety is the overarching goal the ADOT's operations, but the ADOT's approach via building safe roads and airports is different than, for example, the EPA's approach of limiting public exposure to carcinogens. The goals and charges of all the agencies can be reconciled into a workable SOP, but the coordination effort should not be underestimated.

Here is a putative outline of the SOP required for safe use of NOA and the steps likely required to garner wide stakeholder approval of the SOP.

1. The SOP includes
    a. site investigation and characterizations
        i. Laboratory practices
    b. review of design alternates to use non-NOA materials
        i. Cost analysis
    c. evaluation of human health concerns and agency involvement
    d. designs that use NOA
        i. typical drawings and specifications
    e. acceptable construction practices
        i. typical contract provisions
        ii. QA/QC
    f. acceptable and required O&M practices
        i. State forces
        ii. Local forces
    g. O&M and other issues related to in-place NOA

    h. the administrative procedures for the entire process, including lines of authority and approval authority
        i. interagency communications
        ii. documentation
2. For each project or situation
    a. a site specific NOA plan
    b. including outline construction specifications or O&M procedures
    c. public involvement and education
    d. QA/QC

However to be successful, the SOP must be acceptable to

- The agencies who may have some jurisdiction or be involved
- The DOT design, construction and O&M staff and experts
- The contractors and material site owners and suppliers
- The general public
- Involved and concerned public.

Thus, we recommend the ADOT take the lead and develop a NOA Action Plan that involves a consultant to the DOT. Here are the main steps of that Action Plan that will lead to a workable SOP:

- Outline the SOP
- Contact all interested parties and notify them of the Action Plan and request a statement of their interest
- Meet with all the major players and discuss the issues – either at a roundtable or individually
- Prepare a draft of the SOP and an example Site Specific Plan for ADOT review
- Distribute the draft to interested stakeholders
- Hold a meeting to review the draft and discuss comments and changes
- Determine if new laws or regulations are needed
- If not, the ADOT promulgates the SOP
- If new laws or regulations are needed, ADOT starts the process.

INTRODUCTION

Asbestos is a term for naturally occurring silicate minerals with long, thin fibrous crystals that were historically mined and utilized in a wide-variety of manufactured products because of favorable chemical and physical properties. By the 1980s inhalation of asbestos fibers was found to be a human carcinogen responsible for diseases such as asbestosis, mesothelioma and lung cancer and the mining and use of asbestos in manufactured products was banned. While mining and manufacturing has since ended in the United States, Naturally Occurring Asbestos (NOA) is a constituent of some rocks and soils existing in varying types and quantities in several locations throughout the nation including Alaska. The United States Occupational Safety and Health Administration (OSHA) regulates asbestos exposure in the workplace; however, federal regulations do not address non-occupational exposure from NOA. Due to the lack of regulatory guidance associated with NOA, some states with substantial NOA concerns, such as California, have implemented state-wide regulations controlling the use of soils with NOA.

Due to geography, land mass, limited road systems and relatively sparse and scattered population centers within Alaska, NOA has not been a historical concern for the state. However, over the past several years NOA has been encountered in Alaska and has impacted state projects (e.g. Dalton Highway, Ambler, etc). Meanwhile the Alaska Department of Transportation & Public Facilities (ADOT) has an ever-increasing demand for gravel and rock to construct and repair the state's roads and airports. Large construction projects such as the proposed gas line or railroad extension will require gravel and rock source development.

The ADOT contracted with the Institute of Northern Engineering (INE) of the University of Alaska Fairbanks through the Alaska University Transportation Center to report on the available background information in Alaska and a literature search of information from other states that have similar NOA issues. INE contracted with Nortech Environmental, an Alaska consulting firm, to provide expertise in asbestos issues in Alaska, and to perform the literature search and consultations with other states.

This paper reviews NOA background, analytical issues, policies and regulations that have been considered and/or implemented by other authorities involved with NOA and who have developed NOA policy options. Identified NOA control strategies and technologies are evaluated and analyzed according to their effectiveness, enforcement, affordability and consistency with emerging US standards and ADOT programs. The literature is clear that NOA gravels can be used safety with proper workforce training, understanding and implementation of appropriate control strategies and technology. Implementation of effective Alaskan NOA policies, including development of any SOP to deal with NOA, will require program consensus, including an educational component, and must involve all stakeholders in the NOA issue (resource owner, owner, designer, contractor, local, regional and state government, and communities) in a holistic approach.

BACKGROUND

Asbestos History

The word 'asbestos' is of Greek origin and has the meaning "inextinguishable" or "indestructible." Today asbestos is the commercial term for a group of silicate minerals consisting of magnesium, calcium and iron all with fibrous tendencies. The favorable properties of asbestos were known and utilized by the ancient Greeks and Romans, Europeans throughout the Middle Ages, and most of the industrial world by the modern era. Asbestos was added in manufactured material for thermal and electrical insulation as well as for strength and chemical stability. These favorable traits lead to the continued use of asbestos in manufactured products through the industrial expansion of the 20th Century. By mid-1960 a high frequency of respiratory disease within the asbestos mining, manufacturing, shipbuilding and construction industries began to gain the attention of medical researchers.

Asbestos is naturally occurring in many parts of the world and was historically mined as raw ore. After the ore was segregated, the asbestos was broken down into fibers and fiber bundles during a milling process, and then further refined depending on the use. Asbestos was included in the manufacture of thermal piping insulation and spray-applied fireproofing as well as resilient floor coverings, acoustical materials, gaskets, plaster, vermiculite, joint compound, wall board, roofing products, industrial mastics, textile and friction productions such as automotive brakes.

In mineralogy, the word 'asbestos' describes a series of magnesium silicate minerals that naturally occur in fibrous form or 'asbestiform.' The six varieties of recognized asbestos minerals comprise two mineralogical groups: serpentines and amphiboles. The only variety of serpentine asbestos is chrysotile or 'white asbestos,' while the amphibole group has five mineral varieties: amosite or 'brown asbestos' (cummingtonite-grunerite asbestos), crocidolite or 'blue asbestos' (riebeckite asbestos), anthophyllite asbestos, tremolite asbestos and actinolite asbestos. Amosite and crocidolite are the trade names used for the asbestos varieties of the cummingtonite-grunerite and riebeckite series respectively. The name 'Amosite' originated as an acronym for "Asbestos Mines of South Africa."

Chrysotile is the predominant asbestos variety used commercially in the United States. Chrysotile has a crystal structure of a sheet of silicate rolled into a straw-like, hollow tube. The property creates a hydrophilic or 'water loving' tendency, and therefore water is often used to reduce airborne chrysotile fiber concentrations during processing and removal activities. Crocidolite and Amosite are the two additional asbestos varieties exclusively mined and intentionally added to commercial products. The other three forms of amphibole asbestos are generally found in trace amounts and are often described as a contaminant in mining operations. The crystal structure of amphiboles is a chain structure of magnesium and silicon ions that form into long straight fibers. The molecular arrangement makes the amphiboles hydrophobic or 'water fearing' and difficult to wet and therefore, water is somewhat less effective as dust control with this group.

Asbestos has become a serious health and safety concern due to widespread use in manufactured products; many of which are still used today. The primary pathway of exposure for asbestos is inhalation of airborne fibers; ingestion is generally a minor pathway. Particles smaller than 10 µm in aerodynamic diameter, such as asbestos fibers, are known to readily enter the lungs. Asbestos dust may also be ingested directly into the mouth during respiration, hand-mouth contact while eating or smoking, or indirectly by swallowing of mucus. Dermal exposure to asbestos has been known to cause irritation; however, no serious health effects from skin exposure have been identified.

Asbestos is known to cause or contribute to fibrosis and malignancies of the lung and other organs. The U. S. Environmental Protection Agency (EPA) has classified asbestos as a Group A human carcinogen meaning sufficient evidence exists to connect exposure and human carcinogenicity. Exposure to airborne asbestos has been linked to Asbestosis- a debilitating, non-malignant lung disease; mesothelioma – a rare cancer of the chest and abdominal lining, and cancers of the lung, esophagus, stomach, colon and other organs. Other conditions associated with asbestos exposure are build-up of fluid in the lungs known as pleural effusion and deposits in the pleural cavity called pleural plaques.

Data from asbestos work exposure suggests the risks of asbestosis and lung cancer are "dose-dependent" meaning they decrease proportionately with a decrease in total asbestos exposure. Mesothelioma however is not recognized as a dose-response related illness and has been linked to primarily amphibole asbestos exposure.

The time between exposure and resulting disease is known as the latency period, and typically spans between ten and forty years. The age at which asbestos exposure occurs is relatively unimportant for determining the lifetime risk of lung cancer. On the other hand, the age at which asbestos exposure occurs is very important in determining the lifetime risk of developing mesothelioma. The earlier exposure occurs, the more time mesothelioma has to develop; thus the concern for asbestos exposure to school children.[1]

Asbestos exposure and cigarette smoking increases the lung cancer rate significantly above the rate due to either smoking (ten times) or asbestos exposure (five times) alone. A smoker routinely exposed to asbestos experiences a synergistic effect from the two thereby increasing their risk of developing a lung disease by fifty to ninety times more than a person who does not smoke and is not exposed to asbestos. OSHA standards require employers of workers who are exposed to asbestos to be provided information packets on smoking cessation programs and to ban smoking in all workplaces where any asbestos exposure is possible.

Asbestos Regulations

Although NOA is not regulated per se, here we review the most important asbestos regulations. The EPA regulates asbestos products primarily under three laws:

- Clean Air Act (CAA), at 40 CFR 61 Subpart M – National Emission Standard for a Hazardous Air Pollutant – Asbestos (NESHAP);
- Toxic Substances Control Act (TSCA), at 40 CFR 763 Asbestos; and
- Asbestos Hazard Emergency Response Act (AHERA) which amended TSCA in 1986.

Asbestos is further regulated by several federal agencies and some Alaska agencies.

NESHAP

The asbestos NESHAP regulates the emission of asbestos from the workplace into ambient air primarily during removal activities, building renovation/demolition and associated waste disposal operations. The NESHAP allows no visible emission of asbestos from the workplace during any regulated activity.

Three key NESHAP concepts are 'asbestos-containing material' (ACM), 'friable' material, and 'Regulated ACM' (RACM). A material is defined as ACM if it contains more than 1% asbestos as determined by polarized light microscopy (PLM) analysis. Untested materials identified as suspect by an accredited inspector must be Presumed ACM (PACM). Friable is defined as a material that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. Nonfriable materials are subdivided into Category I nonfriable (packings, gaskets, asphalt roofing products and resilient floor covering) and Category II nonfriable (such as wallboard, cement asbestos products, asbestos-containing plasters, and any nonfriable ACM not listed in Category I). Category II nonfriable ACM are materials that may become friable during handling or disposal.

RACM includes all friable ACM, nonfriable ACM that has become friable, Category II materials that will be made friable by the proposed activity and all Category I materials that will be subjected to operations causing fibers to become airborne. Prior to the demolition or renovation of any non-exempt structure in the United States, the owner or operator of the facility must inspect for the presence of asbestos, including Category I and II non friable ACM. NESHAP requires building owners and operators to notify the EPA (or a designated state agency) before demolishing any non-exempt structure. In addition, it requires a ten day advance notification if scheduled activities will disturb equal or greater than (≥) 260 linear feet on pipes, ≥160 square feet on surfaces and ≥35 cubic feet of debris of RACM. The NESHAP standard also prohibits emissions of asbestos to the outside air and requires emission control procedures and appropriate work practices during collection, packaging, transportation and disposal of regulated ACM waste.

AHERA

EPA issued regulations pursuant to the 1986 Asbestos Hazard Emergency Response Act (AHERA) in October of 1987. AHERA applies to public, nonprofit private and Defense Department kindergarten to twelfth grade school buildings. It requires them to conduct ACM inspections, develop comprehensive ACM management plans, and select asbestos response actions to deal with asbestos hazards. AHERA established a series of accredited personnel and set the training requirements for each. The AHERA occupational survey does not require inspection of all portions of the school (ie exterior, roof etc) nor the removal of asbestos identified, but does require that schools select and implement an appropriate response action for each identified asbestos hazard. The response action may be encapsulation, enclosure, removal or an approved Operations Maintenance and Repair Program (O&M Program). Encapsulation deals with applying a chemical coating or impregnation of the ACM building material in order to prevent any fiber release, while enclosure consists of sealing the ACM in an airtight structure. O&M Programs and Management in Place (MIP) are generally the most utilized and preferred response method until the ACM has become deteriorated or will be impacted by renovation activities thus requiring removal.

The Asbestos School Hazard Abatement Reauthorization Act (ASHARA) was enacted on November 28, 1990. ASHARA amended AHERA to require accreditation for any person who inspects for ACM in a public or commercial building, or who designs or conducts a response action with respect to friable ACM in such a building. ASHARA does not require building owners to conduct inspections for asbestos-containing materials in public and commercial buildings; however, should the owner decide to conduct an inspection an accredited inspector must be used.

TSCA

EPA's Asbestos Ban and Phase Out Rule (ABPO) (40 CFR 763 Subpart I) was published in the Federal Register on July 12, 1989, under TSCA. The rule was to prohibit the importation, manufacture and processing of 94 percent of all remaining asbestos products in the United States over a period of seven years, beginning in 1990. However, the U.S. Fifth Circuit Court of Appeals vacated most of the ABPO and remanded it to EPA in October 1991. EPA subsequently banned several paper products and has used general TSCA authority to control re-introduction of asbestos products into the market place.

OSHA

OSHA currently has three standards for asbestos exposure. The general industry standard, 29 CFR 1910.1001, applies to all occupational exposures to asbestos in all industries except the shipyard and construction industries. This standard would apply to workers handling NOA if exposures were above the PELs. The shipyard standard, 29 CFR 1915.100, applies to asbestos exposure in all shipyard work and the construction standard, 29 CFR 1926.1101, applies to asbestos exposure in all construction work, including demolition and building maintenance.

All three standards are similar, with each standard setting two permissible exposure limits (PEL), the time-weighted average (TWA) and the excursion limit (EL). The TWA is 0.1 fiber per cubic centimeter of air (f/cc) averaged over an eight-hour period, while the EL is 1.0 f/cc averaged over a 30-minute period where exposure is likely to be the greatest. Each standard specifies training, medical monitoring and recordkeeping requirements for employers of workers who are exposed to asbestos. Differences exist primarily in the areas of effective dates for worker training, medical monitoring, and in work practices specific to the industry. The construction standard is the most detailed and divides asbestos work into classes, I-IV, based on the type of the material, the work being performed, how the material will be impacted, and the amount of ACM involved in the work. For all construction work scheduled to impact PACM or ACM, a competent person must conduct an initial exposure assessment to determine employee worst-case exposure and to establish the engineering controls, work practices, and personal protective equipment that may be required. The standard also supplements the OSHA Hazard Communication Standard (29CFR 1910.1200 and 29 CFR 1926.59) by requiring building and facility owners to notify prospective contractors and subcontractors, tenants, and the owner's own employees about the presence, location and amount of PACM and ACM in the building. This standard requires owners to conduct asbestos inspection or surveys so that the necessary information is available for compliance with notification requirements. The General Industry Standards would apply to workers handling NOA if there exposure were over the PEL.

DOT

The U.S. Department of Transportation (DOT) regulates the transportation of hazardous materials including friable asbestos under the Hazardous Materials Transportation Act (HTMA). DOT's hazardous materials regulations (HMR) are found at 49 CFR 171-180. These regulations require the proper packaging, labeling, shipping manifests, marking, placarding and trained employees associated with shipping of ACM and waste. Proper shipping papers must accompany asbestos-containing shipments with packages properly marked and labeled with the Class 9 diamond. The markings must include the North American identification number, NA2212, and the proper DOT descriptive name (RQ, Asbestos 9, NA2212, PG III). Laboratory samples in shipment are exempt from the regulations, except for the packaging requirements of 49 CFR 173.4.

MSHA

As of April 29, 2008, the U.S. Department’s of Labor Mine Safety and Health Administration (MSHA) revised exposure limits on asbestos for miners. The ruling changes health standards for asbestos exposure at metal and nonmetal mines, surface coal mines and surface areas of underground coal mines. The new ruling lowered MSHA's permissible exposure limits to match those of OSHA. The previous MSHA PEL of 2.0 f/cc was once the same as OSHA's; however, MSHA has not made continuing amendments to the standard in past years which reduced the PEL to 1.0, 0.5, 0.2 and eventually 0.1 f/cc. In addition, the ruling allowed for Phase Contrast Microscopy (PCM) to analyze airborne asbestos samples and Transmission Electron Microscopy (TEM) to reanalyze samples found to be above the PEL via PCM.

Alaska

The Alaska Department of Labor (ADOL) has adopted, with a few modifications, the federal regulations OSHA for asbestos and asbestos removal activities. Federal government has delegated authority to the Alaska Department of Environmental Conservation (ADEC) to implement federal programs which extend the NESHAP, ASHARA and AHERA requirements and the Alaska Department of Occupation Safety and Health (AKOSH) to oversee worker protection.

Other States

Some states have adapted more stringent AHERA and OSHA type regulations, and in some large metropolitan areas the city regulates asbestos and asbestos abatement directly. Other states such as California have developed statewide policies concerning issues not addressed in Federal regulations such as Naturally Occurring Asbestos (NOA) found in soils and rock.

Relevancy of Regulations

None of these regulations, except California and Virginia, discussed elsewhere, apply directly to NOA as likely to be encountered by the AK DOT. The MSHA and ADOL/OSHA regulations apply regarding worker exposure, if workers were exposed over the PEL. The detailed ADOL/OSHA regulations regarding asbestos demolition and disposal do not apply to NOA.

Naturally Occurring Asbestos

Naturally Occurring Asbestos (NOA) has been generally accepted as the generic term to identify any of the six (Chrysotile, Amosite, Crocidolite, Actinolite, Tremolite, Anthophyllite) varieties of asbestos when encountered in natural geological deposits. Asbestos is not chemically altered through a refining process to obtain the hazardous end product we encounter in manufactured goods; but rather raw asbestos ore is mined and crushed down into a usable form. Consequently, NOA describes the location of asbestos (in situ rock and soil) rather than a variety of asbestos.

The mineralogical community uses the term “asbestiform” to describe the morphology of a mineral which has longitudinal parting and can be split into individual fibers. Not all asbestiform minerals are regulated varieties of asbestos; however, all regulated asbestos are asbestiform. Asbestiform minerals consist of fibers that grow almost exclusively in one dimension, are easily bent and occur as bundles of smaller fibers which are called fibrils. This bundling effect of asbestiform minerals is used as a unique distinguishing feature. Asbestiform minerals are long and thin, with aspect ratios of typically 20:1 to 100:1 or greater. Most asbestiform fibers are less than 0.1 microns in width, and nearly all are less than 0.5 micron. Individual asbestiform fibers are visible only with the aid of a microscope. It is important to note these forms became regulated due mainly to their presence in commercial products and several other asbestiform minerals exist, in addition to the six regulated forms, and may be encountered in natural deposits and pose heath hazards similar to that of the regulated varieties.

Geologic Occurrence of Asbestos Minerals

Metamorphic rocks are the result of the transformation of a protolith (existing rock) in a process called metamorphism during which the protolith is subjected to heat and pressure causing profound physical and/or chemical change. Prior to the transformation, the protolith may begin as sedimentary rock, igneous rock or another older metamorphic rock. A large portion of the Earth’s crust is composed of metamorphic rocks which are classified by texture and by chemical and mineral assemblage. They may be formed simply by being deep beneath the Earth's surface, subjected to high temperatures and the great pressure of the rock layers above it. They can be formed by tectonic processes such as continental collisions which cause horizontal pressure, friction and distortion or when rock is heated up by hot molten rock, magma, from the Earth's interior, later referred to as igneous intrusion.

Serpentines (Chrysotile) are a magnesium silicate, while amphiboles are generally iron-magnesium silicates with varying amounts of sodium and calcium. If the protolith contains these chemical components asbestos formation is more likely than those that do not. All rocks which have this chemical composition have the potential to contain amphibole asbestos or serpentine asbestos; however, the non-asbestiform varieties of these minerals considerably more dominant than asbestiform.[2]

Asbestos minerals are generally associated with ultramafic rocks and their metamorphic protolith, including serpentinite (serpentine rock). Ultramafic rocks are those igneous rocks composed mainly of iron-magnesium silicate minerals, such as olivine and pyroxene. They include the rock types dunite, peridotite, pyroxenite, and hornblendite. Ultramafic rocks form in high-temperature and high-pressure environments deep beneath the earth’s surface. By the time they are exposed at the earth’s surface, ultramafic rocks have typically undergone a type of metamorphism known as serpentinization, a process that alters the original iron-magnesium minerals to one or more waterbearing magnesium silicate minerals (lizardite, antigorite, chrysotile) that belong to the serpentine mineral group. The mineral chrysotile is often present as asbestos in the resulting rock. Metamorphism of ultramafic rocks and serpentinite may also lead to the formation of amphibole asbestos minerals. Conditions favorable for asbestos formation may occur repeatedly during the metamorphic process and, consequently, it is very common for at least a small quantity of asbestos to be present in metamorphosed ultramafic rock bodies. [3]

While generally associated with serpentinite and ultramafic rocks, chrysotile asbestos may less commonly occur in other rocks that originally contained the minerals olivine and pyroxene. These include metamorphosed mafic plutonic rocks like gabbro or mafic volcanic rocks such as basalt that are commonly associated with ultramafic rocks or serpentinite. Chrysotile and the amphibole forms of asbestos may also form in magnesium-rich limestones and dolomites which are metamorphosed carbonate rocks. The amphibole asbestos minerals are most commonly found in metamorphosed ultramafic rocks, including serpentinite, and in metamorphosed mafic plutonic rocks, metamorphosed mafic volcanic rocks, metamorphosed iron-rich chert, and metamorphosed ironstones. In many of these geologic environments, Asbestos is thought to be more likely found where changes in the geology occur such as near geologic contacts, along dike boundaries, or near inclusions of different rocks or in fault and shear zones where natural fluid flow has been enhanced. [3]

Asbestos minerals may also be found in sedimentary rocks, stream sediments, or soils derived from parent materials that contain asbestos. Alluvial deposits that contain asbestiform materials are likely to be found in any watershed that drains ultramafic rocks.[4]

Soils derived from parent materials that contain chrysotile asbestos and amphibole asbestos may also contain asbestos fibers and are an important potential source of airborne asbestos. Weathering and leaching reduce the amounts of asbestos in soils over time, yet little is known about the rates of weathering and leaching of asbestos in soil environments. Available information suggests that substantial reductions in the amount of chrysotile may take hundreds or thousands of years, depending on the soil environment, and somewhat longer for amphibole asbestos. [2]

NOA in USA

In the United States, the presence of asbestos or asbestiform minerals in rocks has been identified in 20 states, and mined in 17 states in the last 100 years. [5] In addition to known previous mining locations, reports of asbestos or other fibrous minerals has been identified through geological surveys and other miscellaneous encounters. The United States Geological Survey (USGS) has an ongoing effort of compiling these sites and locating them on maps that are available on its website at http://tin.er.usgs.gov/mrds[6]. The sites on these maps give an indication of the major areas of concern, which are most particularly located along the Appalachian and Rocky Mountains as well as in the Western Cordillera. In some of these areas, such as California and Virginia, the NOA issue has been known for some time and local agencies have responded in a variety of ways such as implementing state and local policies and regulations for testing and handling suspect and known NOA. The health risks associated with NOA are based on the potential for exposure. The exposure pathway of greatest concern is through inhalation, which requires the asbestos to become airborne. Experts believe that natural factors such as wind erosion pose little threat to human exposure, but rather disturbance of NOA-containing rock and soil under dry conditions. Because of this health risks are generally quantified though activity-based sampling on a site-specific basis. Below is a list of some areas in the US where NOA has been identified, and local responses to the occurrence:

Virginia

In 1987 the presence of NOA in Fairfax County, Virginia, was brought to the attention of the Fairfax County Air Pollution Control Division (Fairfax APCD) during the construction of an underground parking garage. As a result from the NOA-containing rock being drilled and crushed with no mitigation controls in place, the entire construction project was reportedly covered with NOA-containing dust. Several drill operators experienced itching and skin irritation which through subsequent medical and geological investigations was determined to be caused by tremolite asbestos fibers. The Fairfax County Soil Science Office later performed sampling and found a vein of asbestiform actinolite and tremolite comprising 10.9 square miles. Since the NOA discovery, Fairfax County has implemented NOA-specific policies regarding construction project that will impact soil.[7]

California

Serpentinite is California's official state rock and the source of much of the NOA found there. El Dorado Hills, a community in the Sierra foothills near Sacramento is a community that has had ongoing NOA issues associated with fibrous amphiboles in bedrock and soils since 1999. Reports have indicated that airborne concentrations of asbestos regularly reach levels of concern through non-construction activities such has recreation and gardening. In February 2002, during a construction project at a local school, veins of asbestos-containing minerals were discovered. The school soil was remediated that summer, but in September 2003, the EPA carried out activity-based sampling which involved measuring NOA in the breathing zone during recreational activities around the school which yielded varying results of airborne asbestos concentrations. Results underwent criticism for analysis methods and definition of asbestiform vs non-asbestiform minerals; however, a generally consensus was reached that a potential health risk existed for asbestos exposure existed in the area.[8]

Minnesota

Silver Bay, located on the shore of Lake Superior, served as a processing mill for Northeastern Minnesota's is rich in iron-ore mining operations. Historically the lake not only served as a steady water supply, but also as a dump site for the mine tailings. Amphiboles are known to be present in this area iron-oxide ore, and mineral fibers were later detected in the air and water supply of several towns, including Duluth. In 1975 after ongoing legal battles, the 8th Circuit Court of Appeals instituted the "control-city" standard where air monitoring at Silver Bay was required to yield results equal to or less than the control city; in this case St. Paul. [8]

New Jersey

A milling facility associated with a marble and limestone quarry near Sparta, NJ has been accused of emitting fibrous tremolite in dust generated from milling and quarry activities. The geology of the area suggests that amphibole minerals are present; however, emissions testing illustrated that the tremolite mineral present was non-asbestiform. Samples were later collected from homes in close proximity to the quarry which did not yield conclusive evidence that asbestos had migrated from the quarry or milling operation. Analysis methods and the definition of asbestos were again scrutinized; however, the quarry and milling facility are still operational.[8]

Washington

On Sumas Mountain in western Washington State a major low-moving landslide is occurring in altered serpentinite rock near the headwaters of Swift Creek. The landslide material contains both asbestiform and non-asbestiform lizardite, resulting in chrysotile being the asbestiform mineral of concern. Erosion resulting from the slide releases large quantities of sediment into the drainage and eventually the area river. To prevent flooding, the river is routinely dredged and staged in piles along the river. This staged material has historically been utilized as a local source of fill and has formed an area used for recreational activities. In 2006, the US EPA engaged in activity-based sampling in which three activities involving different levels of disturbance of the dredged material were simulated for this study: loading and unloading of dredged material with heavy equipment, shoveling and raking dredged material over a surface, and recreational activity, such as biking, jogging and walking on the dredged materials. Sampling indicated that a potential health risk regarding airborne asbestos fibers existed for several of the activities. In 2007, the US EPA released a fact sheet warning residents to limit their exposures through avoiding contact with the dredged materials. [8]

Montana

Libby is a small town located in the northwest corner of Montana approximately 35 miles East of Idaho and 65 miles south of Canada. In the 1880's, gold miners discovered vermiculite near Libby, and by 1920 the Zonolite Company had formed and began mining the vermiculite. Vermiculite is used in many common commercial products, including attic insulation, fireproofing materials, masonry fill, and as an additive to potting soils and fertilizers. In 1963, W.R. Grace purchased the Zonolite mining operation which remained in production until 1990.[9] In the fall of 1999, a series of newspaper articles state the ore deposit contained small amounts of asbestiform amphiboles. In response to these articles, the EPA sent an Emergency Response Team to Libby in November 1999 to address the asbestos concerns. The vermiculite ore mined from Libby was contaminated with fibrous amphiboles consisting of tremolite and the asbestiform amphiboles winchite and richterite. [8]Tremolite is a regulated form of asbestos; however, papers by Meeker[10] and Gunter[11] concluded that tremolite made up less than 10% of the amphibole population suggesting the winchite and richterite likely contributed to the increase in asbestos related illness affecting the former Libby miners. Multiple studies yielded results illustrating that rates of lung cancer, asbestosis and mesothelioma were about 2.5 times higher in the Libby miners than expected. [8]

EPA implemented a program to inspect all Libby properties for elevated asbestos levels. Between 2002 and 2003, approximately 3500 properties were inspected, with 12,000 soil samples being collected. As of 2009, the EPA has completed cleanups at over 1100 properties including the vermiculite processing plants and other "highly contaminated" public areas with an estimated 100 large property cleanups scheduled for the 2009 constructed season.[9]

Analytical Methods for Quantifying Asbestos in Soils

Various types of microscopic analysis are used to determine the amount of asbestos present in soils. The most common forms are discussed below. Additionally, variations exist for each method depending on sample preparation and counting methods utilized.

Polarized Light Microscopy (PLM)

PLM analysis is the standard method used to test for the presence or absence of asbestos in building materials. PLM results report a visual estimation of the weight percentage of asbestos in a sample. PLM analysis typically begins by viewing a sample under a stereoscope at 10X – 50X magnification; fibrous sub-samples are then selected to be viewed under a light microscope at 100X – 500X magnification. By correctly interpreting light interactions, analysts can accurately distinguish asbestos from non-asbestos materials (glass, cellulose) as well as identify the variety of asbestos present. Accuracy of this method depends on the uniformity of the material, the type of analysis and the analyst's experience. "Point Counting" considered more accurate than standard PLM is one variation of the method where the analyst views a set number of grid points and documents the material present. The number of points that have asbestos versus no asbestos determines the percentage of asbestos reported. [12]

Common forms of PLM analysis are not applicable for materials which contain highly varied, non-uniform and non-manufactured materials such as soils, gravels, dusts or large quantities of fibers smaller than 0.25 µm.

Transmission Electron Microscopy (TEM)

TEM is capable of identifying the largest range of asbestos fibers/structures of all Electron Microscopy analysis and can differentiate between asbestos and non-asbestos fibers/structures. TEM is used for air, bulk, dust and soil sampling. TEM analysis utilizes an electron microscope for which the level of magnification can resolve down to10 nanometer (nm) particles and can identify asbestos particles by appearance, chemical composition and crystalline structure. Depending on the variation of TEM analysis results are either a visual estimation of a weight percent, or are "semi-quantitative" based on actually weighing the sample then estimating the weight of asbestos found by the fibers size and density.

In addition to bulk sample analysis, TEM is also used to analyze microvac (ASTM D-5755) and wipe (ASTM D-6480) samples. These sampling techniques are common to quantify asbestos levels in settled dust. Both methods require settled dust to be collected from a known surface area. The laboratory analysis consists of digesting the media (filter or wipe) in solution and analyzing via TEM. Samples can be qualitatively analyzed which yields an "absent" or "present" result for asbestos and notes the types of asbestos observed. Samples can also be analyzed qualitatively for which the solution with the digested media is diluted known magnitudes until asbestos fibers can be accurately counted with the microscope. By using known sampling surface areas, dilution factors and analysis areas, the microscopist can calculate the amount of asbestos structures present per square centimeter (st/cm^2) of dust. While this method is a very useful tool in determining the concentration of asbestos in settled dust, concentrations of asbestos in settled dust are not regulated by any agency since the asbestos is neither airborne nor present in a building material.

TEM allows for more accurate identification of much smaller fibers than PLM analysis. EPA method 600/R-93/116, Section 2.5[13] summarizes the TEM bulk analysis. Many laboratories have developed their own methods to provide a full quantitative analysis of bulk samples via TEM.

Scanning Electron Microscopy (SEM)

SEM is primarily used for asbestos analysis for air and dust samples with the asbestos fibers being identified using their chemical composition and appearance. Asbestos fibers too small to be detected using light microscopy can be seen.[14] SEM can be used to observe particle down to approximately 0.1 µm. SEM has not historically been heavily used for regulatory purposes; however, recently it has become more popular for studying amphiboles in their natural setting.[15]

CARB Method 435

The California Air Resources Board (CARB) adopted a NOA-specific testing method in 1990 known as CARB Method 435. (M435 or CARB 435) California currently requires this method for the analysis of gravels or mineralized soils to detect the presence of asbestos. In this method, the soil/aggregate sample is weighed, dried, milled (crushed to fine powder) and then analyzed by PLM or TEM. The CARB method is designed to detect "loose" asbestos fibers, unlike sieving methods which are used to analyze ACM mixed in soil.[16]

PLM analysis utilizes either a 400 or 1000 point count to obtain a level of detection of 0.25% and 0.1% respectively. The PLM resolution is only accurate down to 0.25 µm; asbestos fibers/bundles smaller than that (specifically amphiboles) will not be detected using PLM. For the CARB 435 TEM Method the sample is weighed, dried, milled, put into suspension and analyzed. Results are given in percent asbestos by mass with sensitivities down to 0.001%.[17]

CARB 435 results are considered representative of the worst case conditions when the NOA aggregate becomes pulverized due to handling, use application or natural conditions.

EPA Region 1 Proprietary Soil Characterization

This is a proprietary method that separates and analyzes the different portions of the sample. PLM or TEM analysis may be used for the final analysis but the method includes observations of the fractions of materials present, classification by particle size and source categories, including organic, man-made, geological and asbestos materials. Since this method does not alter the materials present for analysis, results represents the materials as they exist in their natural setting. EPA Region 1 Soil Characterization provides a visual estimation of the weight percentage.[18]

Analytical Methods for Quantifying Asbestos in Air

Typically asbestos air samples are collected by "pulling" a known rate of air through a 25mm cassette by either an electric or battery operated vacuum pump. The air is forced through either a 0.45 micron (µm) (TEM) or 0.8 µm (PCM) mixed cellulose ester (MCE) filter which is then analyzed for asbestos fibers/structures by TEM or PLM respectively. The concentration of airborne asbestos is calculated by the density of asbestos present on the filter and the volume of air sampled.

Phase Contrast Microscopy (PCM)

PCM (NIOSH 7400 Method) sampling method is a very common form of determining airborne fiber concentrations using a light microscope. The PCM method counts all fibers meeting the criteria of greater than 5 (μm) in length and 0.3 μm in diameter and meet the 3:1 aspect ratio (whether asbestos fibers or not) and reports results in fibers per cubic centimeter (f/cc) of air. PCM only counts fibers that are present in the fields observed, and does not identify the type of fiber (asbestos, cellulose, fiberglass, ect).[19]

This method is widely used for monitoring airborne fiber concentrations during asbestos removal/impacting projects, including determining OSHA approved worker exposures through a time-weighted average (TWA). TWA's calculate the average concentration of fibers a given worker was exposed to during his/her work shift.

Transmission Electron Microscopy (TEM)

For TEM air sampling analysis, the same collection procedure is used as with PCM sampling, except the cassette filter has a smaller pour size and results are reported in asbestos structures per square millimeter (Str/mm^2).[20] The results are reported in Str/mm^2 since the analysis includes all asbestos particles 0.5 microns and larger in length and may not necessarily be fibers. TEM allows for the analysis of very fine fibers while simultaneously determining their chemical composition and crystalline structure.

TEM Method 7402[21] is typically used when a PCM sample is found to have elevated fiber levels. Method 7402 analyzes a separate piece of the same cassette filter under an Election Microscope, opposed to a light microscope, which allows the analyst to determine if there is actually an elevated level of asbestos fibers, or if the fiber level was elevated due to a high number of miscellaneous fibers meeting the PCM counting criteria. This method is a useful complimentary tool to the PCM 7400 Method.

Elutriator Method

The Elutriator Method (Superfund EPA 540-R-97-028) begins by sieving the soil sample into fine a course fragments. The fine soil fractions are then placed in a closed tumbler chamber where any respirable dust created during tumbling is collected on air cassettes. The cassettes are then analyzed via TEM by ISO 10312[22] counting rules which are designed for samples collected from ambient conditions, specifically indoors. This method is used to identify the amount of respirable fibers present within a soil sample.[18]

NOA AND EFFECTS ON ALASKAN CONSTRUCTION PROJECT

Historical Alaska NOA Incidents

Alaska has large known deposits of ultramafic and serpentine mineral ore located throughout the state. The documented cases of NOA encounters in the state have been limited and comparatively small. The potential for larger and more serious incidents can be expected to increase as public and professional awareness examine proposed activities with more scrutiny and existing material sites are exhausted and new site are developed. The following is a brief synopsis of several known NOA incidents in Alaska.

Juneau

In 2005, NOA was found to be present in Juneau's city-run Stabler's Point Rock Quarry causing several contractors to stop using the material until additional information and guidance was made available. Stabler's Point consists of the hardest local rock, metamorphosed mafic volcanic rock, which has been known to historically contain NOA. According to a Memorandum issued by the City/Borough of Juneau in 2005, scattered veins of asbestos-containing rock have also been reported in the following Juneau quarries: Lemon Creek, Treadwell, Upper and Lower Fish Creek and Bonnie Brae. The city believes that asbestos is likely to be present in most Juneau areas with high quality rock.[32]

Of the initial samples collected from the Stabler's Quarry two were found to contain tremolite asbestos at 3% and 5%.[33] Later some samples were also found to contain actinolite asbestos.[34] Blasting and rock crushing operations, which are known to release asbestos fibers from rock, had been occurring on a regular basis for several years prior to the discovery of NOA at the quarry. A private consulting firm hired by one of the contractors utilizing the quarry later stated given the presence of asbestos at the quarry, and the limited air sampling performed, it would appear as though workers were occasionally exposed to airborne asbestos levels in excess of workplace exposure standards.[34]

The rock aggregate obtained from the Stabler's Quarry was used for several years on a variety of private and commercial construction projects throughout the Juneau area and was a topic of concern for many local residents. In addition, aggregate collection (blasting) and refining (crushing) methods used were performed under general conditions meaning no methods were implemented to reduce airborne fiber concentrations during work activities. Since the discovery of NOA at the Stabler's Quarry, sampling efforts have been performed as well as requiring the use of wet methods and respirators for quarry workers.

As in most situations, once NOA was discovered activity was stopped until an assessment could be performed. In the Juneau case, the majority of the asbestos-containing gravel aggregate was used in construction projects where it would not be left exposed. The quarry itself implemented engineering controls such as PPE for workers and the use of wet methods. In addition, attempts were made to focus mining efforts on portions of the quarry which yielded the lowest concentrations of NOA. Material from this mine is currently only used on projects where it will not remain exposed after completion; such as paved road construction. The City of Juneau originally was researching the possibility of implementing local NOA regulations; however, as of yet no regulations have be made.

Dalton Highway

As described by Perkins et al[5] the Dalton Highway (formerly known as the Haul Road) was constructed in the early 1970's and runs adjacent to the Trans-Alaska Pipeline connecting the Prudhoe Bay oil fields of Alaska's North Slope to the state highway system near Fairbanks. Most of the Dalton Highway is unpaved and is primarily utilized by pipeline employees and truckers supplying the oil fields.

In 2000, the Alaska Department of Transportation & Public Facilities (ADOT) awarded a contract to replace culverts and bridge abutments and to add surfacing material to approximately 20 miles of gravel road from Milepost (MP) 90 to 111 on the Dalton Highway. The project utilized surfacing gravel from a material site (MS) located at MP 105. The project contractor constructed a 1 to 2 foot thick gravel pad at MP 107 for a project staging area and temporary housing site since the closest permanent habitation was located approximately 70 miles away. An estimated 30 truckloads of gravel had been removed from MS 105 before workers noticed several large pieces of fibrous material suspected to be asbestos, after which aggregate extraction from this site was terminated.

After ultramafic rock containing actinolite and tremolite asbestos was confirmed at MS 105, concerns about worker exposure on the project site, as well as potential exposure in the temporary living quarters due to cross-contamination arose. Furthermore, questions were raised on how to safely complete the project, as well as address public health concerns for driving on the Dalton Highway. The project contractor retained a consultant to assess the problem, recommend work plan modifications, provide necessary worker training, perform exposure monitoring and reporting.

Results from the assessment included close to 700 breathing zone air samples collected from workers; 3% of which had asbestos fiber concentrations at or near 0.1f/cc per the NIOSH 7400 PCM[19] method. 36 of those samples were additionally analyzed via NIOSH 7402[21] (modified TEM analysis) which illustrated approximately 40% of the fibers observes were asbestos. Results concluded that workers who impacted the material the greatest, such as bulldozer and grader operators, were at the highest risk of exposure. Asbestos fiber release from rock crushing operations would have presumably been higher. Samples for potential motorist exposure were collected under conditions simulating "worse case scenario" - driving with windows open while following heavy equipment which produced a visible dust cloud – indicated fiber concentrations well below the OSHA PEL.

The discovery of NOA at MS 105 on the Dalton Highway incurred significant delays and added millions of dollars to the project costs. After the assessment was completed, the MS 105 was abandoned for a MS which yielded non-NOA gravel to complete the project. The new MS was tested for the presence of NOA prior to starting work. Existing portions of road bed constructed with NOA along the project length were identified and capped with NOA-free material. Work practices and method of construction was modified to minimize worker exposure and NOA accessibility.

Similar to Juneau, the NOA concern at Material Site 105 on the Dalton Highway was discovered after workers had begun to remove and use the material. During this project; however, the NOA-containing aggregate was used to construct the gravel pad for temporary living quarters, as well as to resurface approximately 20 miles of the unpaved Dalton Highway. The NOA assessment for this project illustrated that some workers were at risk of being exposed to asbestos above regulatory limits, but motorist traveling down the gravel highway, in a “worse case scenario” were not. Regardless of the remoteness of the area and the low health risk it posed to the public, it was agreed that known NOA-containing gravel on the highway would be capped and work practices would be modified to address NOA exposure concerns during project construction. Equipment and camp facilities were decontaminated and workers were provided training. MS 105 was no longer utilized as an aggregate source for the remainder of the project and has been closed indefinitely as an aggregate source.

Ambler

Ambler is Kowagniut Inupiat Eskimo village located in northwestern Alaska along the North bank of the Kobuk River. Ambler is approximately forty-five miles north of the Arctic Circle, one hundred and forty miles east of Kotzebue and three hundred and twenty miles northwest of Fairbanks.

In 2003, the ADOT was conducting routine soil testing in preparation for a scheduled Ambler project requiring the use of gravel aggregate. Tests results reported the presence of chrysotile asbestos in the aggregate samples taken from the local gravel pit. This was the only available gravel aggregate source for Ambler and consequently had previously been used to construct the community airport, roads and utility systems. The pit is commercially owned by the local development corporation (NANA), who closed and placarded the pit soon after the NOA discovery.

All roads in Ambler, including the airport runways, are finished with unpaved gravel surfaces. All-terrain vehicles (ATV’s) are the most prevalent means of transportation and create substantial visible dust, generated from the unpaved community road surfaces, during summer months. In 2007, the Agency for Toxic Substances and Disease Registry (ATSDR) performed an exposure investigation[35] primarily focused on ATV generated dust and potential asbestos exposure for both ATV riders and the general public. The assessment concluded that exposure to visible dust generated from the Ambler roadways created a higher than average health risk concerning asbestos.

In addition to the asbestos related health concerns, several community projects which require the use of the gravel aggregate have subsequently been put on hold or cancelled. In 2004, a multi- year effort was undertaken by R&M Consultants to locate an aggregate source free of NOA. However, no location within a reasonable distance (15-25 miles) was identified that would definitively yield non-NOA aggregate.[36] Since the NOA discovery in 2003, the gravel pit has been restricted from use. Due to the inability to use gravel for regular maintenance, the Ambler runway began to dilapidate until the crown had lost its vertical rise and ruts and potholes became increasingly prevalent and obnoxious due to lack of drainage and replenishing aggregate. The runway was also a major source of dust emissions from the airplanes prop wash during take off and landing. The runway was operated by ADOT that concluded runway repairs were required to continue safe operations. ADOT also decided due to the NOA concern in the community they would apply a dust-suppressing poly synthetic palliative called Durasoil to the surface of the runway after the repairs were complete. ADOT had experienced positive results using this form, and variety, of dust suppressant in other remote areas of Alaska to control fugitive dust. Since no non-NOA containing aggregate sites were available, the known NOA-containing quarry was utilized as the aggregate source for the runway repairs. A consultant was retained to assist with a Ambler public meeting, the development of NOA project work plan, training of project workers, community relations during construction while oversight, monitoring and project reporting. Monitoring documented a Negative Exposure Assessment (NEA) with no air sampling results exceeding the OSHA PEL at any point during the project.[37]

Since the discovery of chrysotile in the Ambler gravel pit, the following NOA-related investigative efforts have been performed to date:

- **Asbestos at Ambler Material Pit Preliminary Assessment**.[38] Alaska Department of Health & Social Services, Division of Public Health, Section of Epidemiology, October 23, 2003.
    - Chrysotile asbestos discovered in Ambler quarry during routine soil testing.
    - Quarry was closed indefinitely.
- **Limited Health Survey**. [39] Alaska Department of Labor and Workforce Development, Occupational Safety & Health Labor Standards and Safety Division, November 2003.
    - School area soil, interior dust and air samples confirmed Chrysotile NOA

  - Recommended material site cap, school cleaning, HEPA filtration and administrative controls to control summer risk
- **Ambler Airport Rehabilitation: Airport Materials Site Investigation**. [36] R&M Consultants. 2004 Geotechnical Report.
  - Soil boring was performed around Ambler area to find an alternative, non-NOA gravel source. Results indicated that no non-NOA gravel source was available within reasonable distance to Ambler.
- **Naturally Occurring Asbestos Summary of Requirements and Recommendations.** [40] Alaska Native Tribal Health Consortium (ANTHC). August 2005
- **Public Health Evaluation and Assessment – Interim Report**. [41] May 20, 2005. Middaugh, John P.
  - Medical records review for residents of Ambler, Kobuk, Shungnak and Kiana, to see if asbestos-related diseases had occurred
  - No asbestos-related diagnoses on death certificate; no mesothelioma cases dating back to 1970
  - On review of chest X-ray, nine people with pleural plaques suspicious for asbestos exposure were identified.
- **Investigation of Possible Environmental Asbestos Exposure in Northwest Alaska – Interim Report**. [42] Chimonas, Marc; Middaugh, John and Arnold, Scott. June 15, 2005: Alaska Division of Public Health
  - Expert review of 130 chest X-rays from villagers 50 and older; interviews conducted
  - Twenty-one individuals with either pleural plaques or pulmonary fibrosis suspicious for asbestos exposure. Some were exposed to asbestos occupationally.
  - Not possible to definitively establish or exclude environmental asbestos exposure as a cause of disease
- **Exposure Investigation Final Report**. [35] Agency for Toxic Substances and Disease Registry. June 2007
  - Chrysotile NOA confirmed in gravel used to construct roads
  - Ambient sampling confirmed airborne NOA, but not likely to be a public health concern
  - Visible airborne dust levels behind four-wheelers exposed trailing riders to a high-level of respiratory exposure and confirmed public health concerns.
- **Federal Aviation Administration, Ambler Airfield, Alaska Winter Exposure Assessment.** [43] ***NORTECH*** Environmental Engineering, Health & Safety. June 2008 Report.
  - FAA technician tasks were performed while personal and area air samples were running. Results indicated area fiber concentrations were below 0.01 f/cc while the personal TWA was below 0.10 f/cc.
  - Frequent cleaning of facilities was recommended.

- **Federal Aviation Administration, Ambler Airfield, Alaska Summer Exposure Assessment**[44] ***NORTECH*** Environmental Engineering, Health & Safety. August 2008 Report.
    - o FAA technician tasks were performed while personal and area air samples were running. Results indicated area fiber concentrations were below 0.01 f/cc while the personal TWA was below 0.10 f/cc. Area samples were also collected while planes landed/took off with all results below 0.01 f/cc.
    - o Frequent cleaning of facilities was recommended.
- **Ambler Airport Dust Suppression**. [37] ***NORTECH*** Environmental Engineering, Health & Safety in association with R&M Consultants. November, 2008 Report.
    - o Utilized NOA-containing gravel to resurface runway using "wet methods" as needed. Palliative applied to runway surface for dust suppression.
    - o Personal and area air monitoring illustrated the PEL and clearance concentrations were not exceeded.

In addition to the studies listed above, a *Naturally Occurring Asbestos Dust Control Working Group* has been established as a result of the Ambler NOA. This working group is a consortium of federal, state and local groups who help to manage and oversee NOA-related projects and concerns in Ambler in the interest of public safety. The group consists of the City of Amber, ANTHC, ATSDR, USRD, HIS, Maniilaq, DOH and ADOT.

Ambler is located between the Jade Mountains and the Cosmos Hills; small mountain ranges along the southern slopes of the Brooks Range. The rocks in these mountains are mineral-rich and contain large ore deposits. Bornite, reportedly one of the world's richest copper deposits, exists within these ranges and major jade deposits are found in the Jade Mountains. Serpentine rocks, commonly containing asbestos, have been mapped in both these ranges.[45, 46] An asbestos mine was temporarily operated at Asbestos Mountain in the Cosmos Hills near Kobuk. The asbestos has apparently been eroded from these rocks and transported throughout the area by glaciers, water and wind. Sedimentary deposits have been found with varying concentrations of asbestos throughout the area.[36]

The NOA found in Ambler poses many issues not previously encountered in Alaska. Ambler requires the use of gravel to maintain the limited road system, runway, public utilities and local projects. With no apparent asbestos-free gravel sources within a reasonable distance and only year round air travel access identifying methods to use NOA safety are significant to the regional corporation source owner and local community. ADOT held public meetings in Ambler to obtain feedback, report progress and provide information regarding NOA, asbestos health hazards, risk and effective methods to reduce exposure (avoidance of visible dust clouds, road watering, regular household cleaning to remove visible dust accumulations, removing footwear prior to entering homes and driving slower on the roads, etc).

Alaskan Construction Projects

The presence of NOA and its effects on construction projects in general, as well as its effects on certain Alaskan Construction projects, are noted in other sections. Here we examine the occurrence of NOA in Alaska and its likely effect on future construction projects. Most heavy construction projects such as dams, roads, airports, pipelines, and railways require large quantities of natural materials, sand, rock, and fill soil. These materials are excavated, processed, and transported to the sites where they are needed. Ideally the transport distance from excavation to installation and the processing steps are minimized. In any case, the excavation, processing, and transport are key cost drivers in most heavy construction projects. If material sources proximate to the project have NOA or are likely to contain NOA, the project owners and designers must make a decision to obtain NOA-free materials further from the project at a greater cost, or to use the NOA materials and make allowances for handing the NOA material in such a manner to keep airborne asbestos fibers and their human health hazards to a minimum. Other sections of this report deal with methods of ameliorating fiber release from NOA-containing materials after they have been installed and regulations in other states that have established standards for NOA materials that establish benchmark concentrations, which, together with prudent work methods, are protective of human health.

This chapter will: examine the need for gravel and similar materials in Alaska, discuss the mineralogy of Alaska with respect to asbestos, present a map of mineral occurrences that may contain NOA and their location with respect to transportation corridors, and examine the implications for projects. Finally we will present some conclusions.

Alaska Gravel Needs

Many heavy construction projects move large quantities of soil within their right of way. These are often called “unclassified materials.” Over these are then placed “classified” or “select” materials. The exact definition and qualities of these material are dependent on the particular type of project and its specifications. These materials generally must be imported from off the right of way, usually from special “material sites.” Here we will just refer to those imported materials collectively as “gravel.” We will discuss them in relation to historical and known current demands for gravel, as well as estimates for future projects.

Highways

Here we discuss some likely gravel needs in the DOT’s Northern Region. Currently, for projects on the highway system, there is gravel available, although it may involve a longer haul distance. Generally, these sources have not been checked for NOA. New sources are needed for the routine maintenance (M&O) activities and routine construction projects. DOT Northern Region used 2 million CY from 64 different material sites in 2007 and 1.6 million CY from 40 different materials sites in 2008.[23] The DOT generally has enough material for maintenance and operations (M&O) and new projects, although most new projects are improvements to existing roads. The large rocks used to armor stream banks and other hydraulic structures is known as "rip rap" and rocks large enough for rip rap are usually scarce.

The Trans Alaska Pipeline System (TAPS) and future 48"Gas Pipeline

The TAPS project used 73 million CY of gravel, total. The workpad required 32 million CY. [24] Of that, the Dalton Highway (Haul Road) required about 13 million CY for its prism. Many access roads to material sites were required for Haul Road construction, and may have been counted in either the Haul Road number or not. Certainly the 225 access roads were counted in the 73 million CY. Thus, if the Haul Road and its material sites were counted in, the TAPS project would have required 50 to 60 million CY of gravel without the Haul Road. The most likely route of the proposed gas line will follow the Dalton Highway and the Alaska Highway, there will not be a major new highway. However we do not believe that Alyeska will allow the gas pipeline to use Alyeska's workpad or construct close to TAPS, therefore new workpads and many new access roads will be required. There will be new camp pads, airports, and compressor stations. Not counting the DOT upgrade work, we estimate that the gas line will need to mine 50 to 60 million CY of new gravel. (Referring the annual DOT usage, the new pipeline will require 25-fold the annual DOT requirement, and most of that in the first year or two of construction).

Special highway construction

If the gas line is built, AK DOT will need to reconstruct many miles of substandard road. Large sections of the Dalton Highway need reconstruction.

Airports

Virtually all airport construction and upgrades require material from local sources. In some locations material is barged in from long distances, but this is expensive. There are about 256 bush airports owned by the ADOT.[25] A new small airport may require 25,000 CY of gravel. In addition, gravel is needed for access roads and maintenance of both the runway and the access roads.

Railroad Extension

There is currently a study regarding extending the Alaska Railroad from Fairbanks to Delta (90 miles) and from Delta through Canada (200 miles).[26] A rough estimate for that yields 14 million CY of fill, gravel, and ballast for the main line. Much of the line would be close to the Alaska Highway. However access roads, camps, and ancillary structures – there will be many bridges – may require another 5 million CY.

Mining and other industry

Mining needs gravel for access roads. Smaller mines generally have some material available on-site, but major new mines will require gravel from outside the mine. Extrapolation from Alyeska's numbers (73 million CY in 800 miles) one could say 91,000 CY per mile of new infrastructure. That would include main road and roads to gravel sources and pads for ancillary structures. Minimizing haul distances is economical, which tends to increase the number of material sites. Two new material sites per mile might be a good estimate.

Balance between Existing and new MS

Most of the smaller scale road maintenance is done with existing gravel sources. The volume is generally not large and the costs of opening a new pit are often greater than the haul costs from a more distant pit. A major project will require a lot of gravel and thus justify the extra costs of opening closer pits. Besides direct costs, safety is an important consideration when hauling of gravel on an active highway, and minimizing the number of construction rigs on a traveled highway is good practice.

Since the existing open material sources are just adequate for current needs, it is clear that many new gravel sources will be needed if any of the major projects come to fruition.

Mineralogy of Alaska with respect to asbestos

"Asbestos" is a commercial term, not the name of a particular chemical or geological rock type. While there are six asbestos types that are regulated due to known human health effects, there are other, similar minerals that are not regulated. Some of these may likewise have adverse health effects. Within minerals of a certain chemistry, some of the mineral may have crystallized into large crystals or masses, while other portions may have crystallized in fibers or bundles of fibers. In general, "Asbestos is defined as certain minerals that have crystallized in a finely fibrous habit, in bundles of easily separable fibers and/or fibers which are composed of smaller diameter fibrils, and with a hair-like elongated shape resembling organic fibers, with exceptionally smooth faces and displaying unusual adamantine or silky luster" [8]

As noted by Gosen[31] asbestos is most commonly defined as the asbestiform variety of several specific, naturally occurring, hydrated silicate minerals. Asbestos typically includes chrysotile, the asbestiform member of the serpentine group, and several members of the amphibole mineral group, including, but not limited to, the asbestiform varieties of (1) riebeckite (commercially called crocidolite), (2) cummingtonite-grunerite (commercially called amosite), (3) anthophyllite (anthophyllite asbestos), (4) actinolite (actinolite asbestos), and (5) tremolite (tremolite asbestos). Other amphiboles are known to occur in the fibrous or asbestiform habit,[27] such as winchite, richterite[30] and fluoro-edenite,[29,28] but usually they have not been specifically listed in the asbestos regulations. The many different ways that asbestos and asbestiform and other related terms have been described are summarized in Lowers and Meeker.[30]

The geological conditions necessary for the formation of NOA have been reviewed and the rock types known to host NOA include serpentinites, altered **ultramafic** and some **mafic** rocks, dolomitic marbles and metamorphosed dolostones, metamorphosed iron formations, and alkalic intrusions and carbonatites.[31] In summary, there are many types of minerals that might contain asbestos, and these include rock types very common in Alaska.

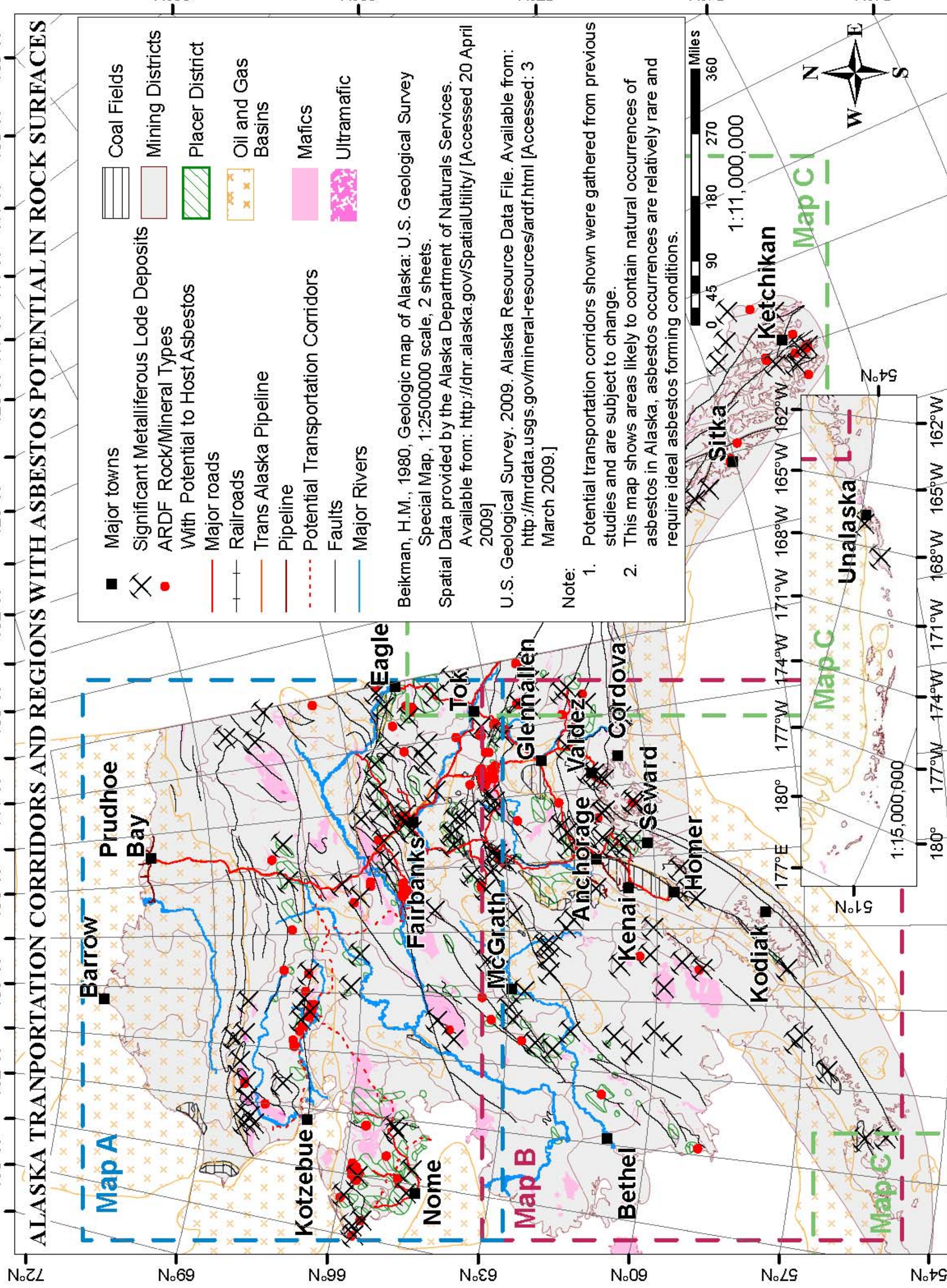
Map of mineral occurrences that may contain NOA and their location with respect to transportation corridors

Next follows some maps that show the regions of Alaska that may contain asbestos, based on the mineral type. The mineral types are taken from the above reference sources, and the mineral locations are based on the USGS map, *Geologic map of Alaska, U.S. Geological Survey Special Map, by H. M. Beikman, 1980*. In addition, in Appendix 3, is the USGS database of all geological exploration and mining that identified asbestos. These have been mapped along with the transportation corridors identified by ADOT planning. Note the northern region had more detailed planning maps.

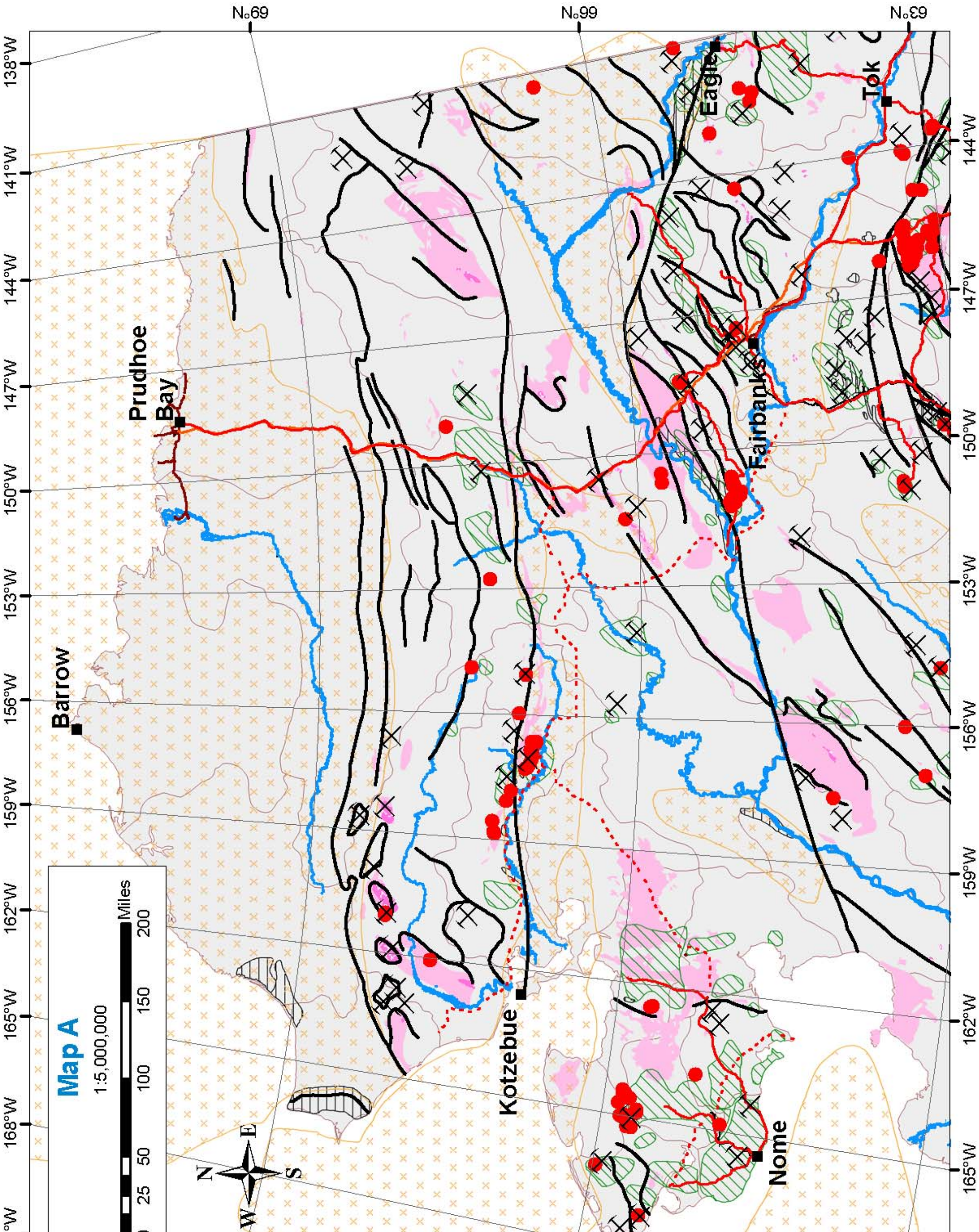
It is important to realize that the map is of the bedrock, or parent material. If the rock erodes, it will move down-gradient via colluvial or alluvial transport. Thus asbestos might be found in sites distant from the origins.

The first map is an index, and the following three maps show greater detail.

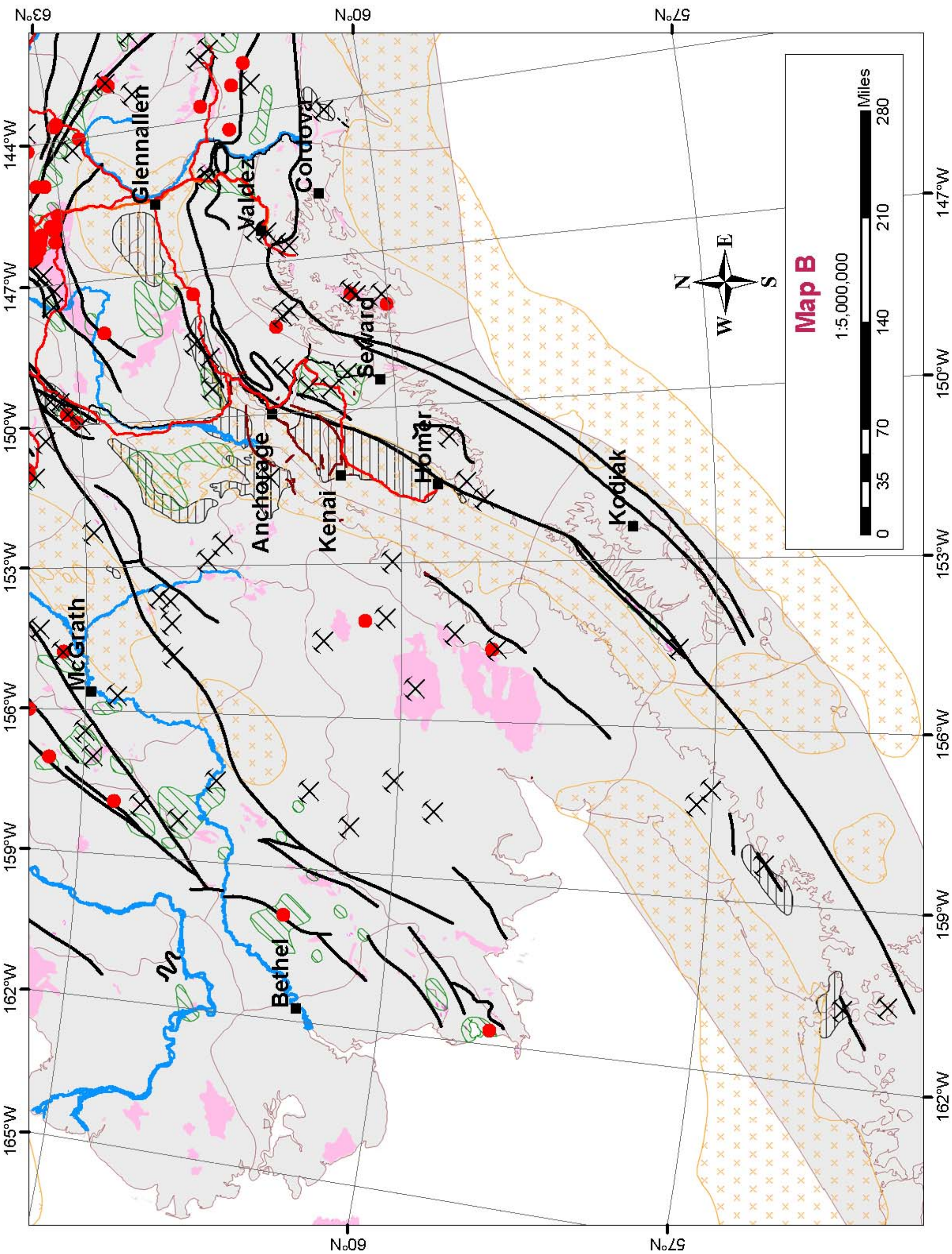
Acknowledgement
The work of Kyle Obermiller, an undergraduate student in UAF's Geological Engineering program on the geological mapping was appreciated and is hereby acknowledged.


ALASKA TRANPORTATION CORRIDORS AND REGIONS WITH ASBESTOS POTENTIAL IN ROCK SURFACES
Major towns
Significant Metalliferous Lode Deposits
ARDF Rock/Mineral Types With Potential to Host Asbestos
Major roads
Railroads
Trans Alaska Pipeline
Pipeline
Potential Transportation Corridors
Faults
Major Rivers
Coal Fields
Mining Districts
Placer District
Oil and Gas Basins
Mafics
Ultramafic
Beikman, H.M., 1980, Geologic map of Alaska: U.S. Geological Survey Special Map, 1:2500000 scale, 2 sheets.
Spatial Data provided by the Alaska Department of Naturals Services. Available from: http://dnr.alaska.gov/SpatialUtility/ [Accessed 20 April 2009]
U.S. Geological Survey. 2009. Alaska Resource Data File. Available from: http://mrdata.usgs.gov/mineral-resources/ardf.html [Accessed: 3 March 2009.]
Note:
1. Potential transportation corridors shown were gathered from previous studies and are subject to change.
2. This map shows areas likely to contain natural occurrences of asbestos in Alaska, asbestos occurrences are relatively rare and require ideal asbestos forming conditions.
Miles
0 45 90 180 270 360
1:11,000,000
1:15,000,000
N E S W
Map A
Map B
Map C
Barrow
Prudhoe Bay
Kotzebue
Nome
Fairbanks
Eagle
Tok
McGrath
Glennallen
Valdez
Cordova
Anchorage
Seward
Kenai
Homer
Bethel
Kodiak
Sitka
Ketchikan
Unalaska

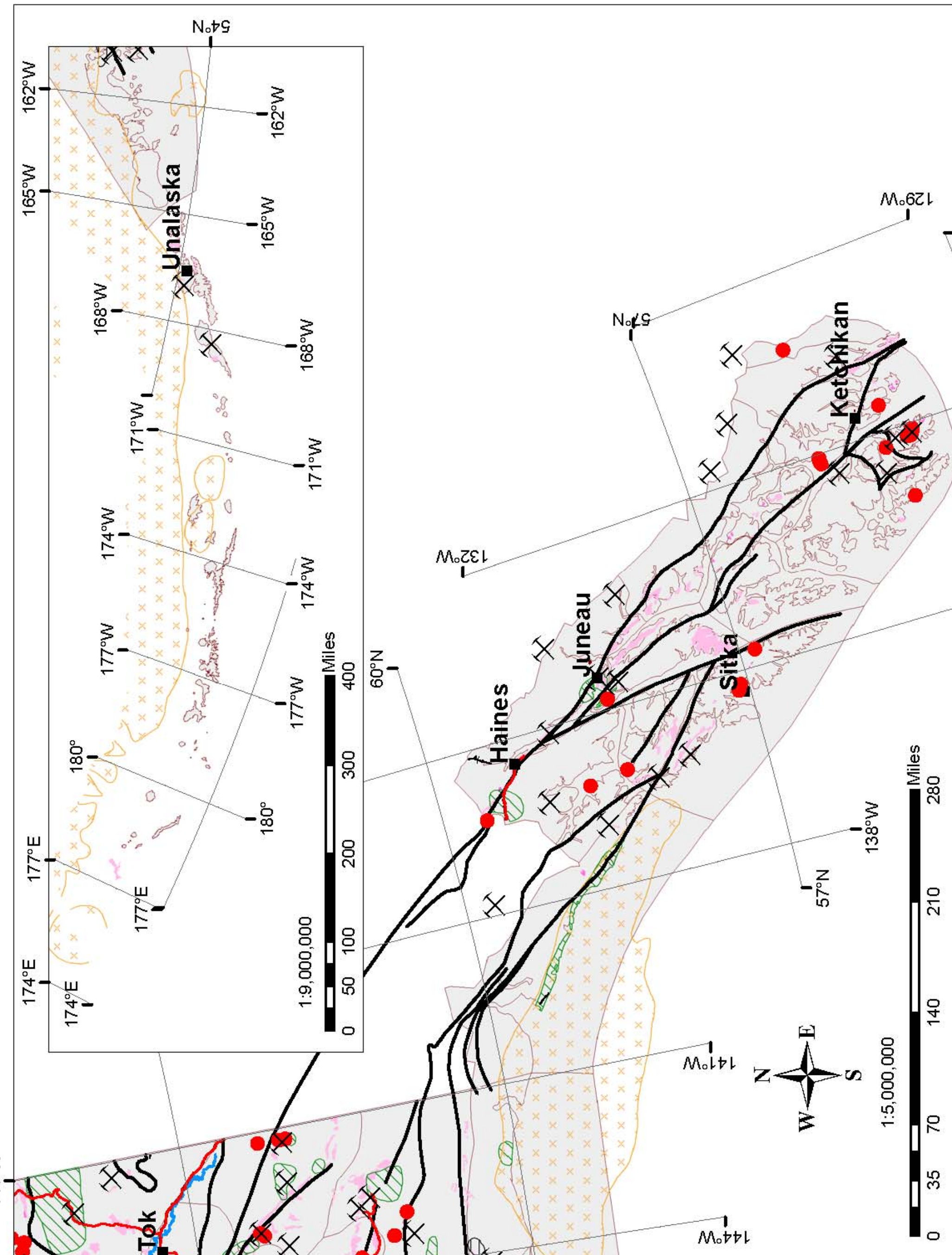
Index Map



Map A, Northern Alaska



Map B South Central



Map C, Southeast and panhandle

Conclusions and recommendations regarding future projects.

It is clear that many of Alaska's current transportation corridors traverse regions containing minerals that may contain NOA. Although Alaska is a huge state, as a practical matter, gravel must be obtained reasonably close to the project. It is also clear that large quantities of gravel will be needed for future projects. While not all the areas that mineralogy mapping has identified as possible asbestos sources will contain asbestos, the mining and geological exploration done in those areas has identified that asbestos is found in these regions. Since asbestos was often found during the exploration for other minerals, it seems likely that asbestos is fairly common in those regions. We know of projects such as Ambler and the Dalton Highway that have been impeded by NOA, thus it is reasonable to expect future projects to be impeded, if they traverse areas with mafic and ultramafic rock and other minerals as identified on the map.

While finding NOA in pre-construction geological exploration is usually a negative for the project, its untoward effects are paltry compared to finding asbestos once construction using the material has started. Therefore all projects that use gravel or other mineral resources in areas identified with mafic or ultramafic rock, or down-gradient or downstream from those minerals must include analysis for asbestos as part of the material site exploration process. If asbestos is identified, its type and extent should be quantified, if possible.

If asbestos is found the project managers must make a decision. Non-asbestos containing earth materials should be used if possible. However if material without asbestos is not readily available, the project managers must make a decision about using the material with NOA or, presumably, importing non-NOA material, or perhaps rerouting or abandoning the project. Using the guidelines and information presented in other sections of this paper will help. Reiterating the key conclusion – if a project's material source is in a region identified on the maps in these chapters as likely to contain asbestos, the material site exploration phase must include an assessment of the material site for asbestos.

Footnote to Chapter

Summary of Asbestos Minerals

Table 1 Summary of minerals where fibrous crystal form or cleavage has generated concern (not an exhaustive list) Mineral Asbestiform or fibrous probability Remarks Serpentine minerals Chrysotile Always Most common type of asbestos; almost the only form mined today Antigorite Rare Amphibole minerals Riebeckite Probable (crocidolite) Previously mined as asbestos in South Africa, Australia and Russia, but not common elsewhere Cummingtonite-grunerite Probable (amosite) Previously mined as asbestos in South Africa. Non-asbestiform habit is common Tremolite-actinolite Probable Widespread occurrence both as asbestiform and non-asbestiform habits, but only rarely mined as abestos Winchite-richterite Probable Rarely encountered Anthophyllite Probable Previously mined as asbestos in Finland and in the eastern USA. Often associated with talc. Arfvedsonite, fluor-edenite, etc. Possible Rarely encountered Zeolites Erionite, mordenite Almost always fibrous Not considered as asbestos, rarely encountered Clay minerals Palygorskite, sepiolite Fibrous habit possible or common Not considered as asbestos, rarely encountered Others Brucite, wollastonite, talc, balangeroite Fibrous habit possible or common Not considered as asbestos, and, except for talc, rarely encountered

Table 1 Summary of minerals where fibrous crystal form or cleavage has generated concern (not an exhaustive list)

Mineral	Asbestiform or fibrous probability	Remarks
Serpentine minerals		
Chrysotile	Always	Most common type of asbestos; almost the only form mined today
Antigorite	Rare	
Amphibole minerals		
Riebeckite	Probable (crocidolite)	Previously mined as asbestos in South Africa, Australia and Russia, but not common elsewhere
Cummingtonite-grunerite	Probable (amosite)	Previously mined as asbestos in South Africa. Non-asbestiform habit is common
Tremolite-actinolite	Probable	Widespread occurrence both as asbestiform and non-asbestiform habits, but only rarely mined as abestos
Winchite-richterite	Probable	Rarely encountered
Anthophyllite	Probable	Previously mined as asbestos in Finland and in the eastern USA. Often associated with talc.
Arfvedsonite, fluor-edenite, etc.	Possible	Rarely encountered
Zeolites		
Erionite, mordenite	Almost always fibrous	Not considered as asbestos, rarely encountered
Clay minerals		
Palygorskite, sepiolite	Fibrous habit possible or common	Not considered as asbestos, rarely encountered
Others		
Brucite, wollastonite, talc, balangeroite	Fibrous habit possible or common	Not considered as asbestos, and, except for talc, rarely encountered

OTHER STATES NOA REGULATIONS

Several large areas of asbestiform mineral deposits exist in the United States. These deposits host both serpentine and/or amphibole minerals in mafic and ultramafic rock formations and have varying concentrations of asbestos. Some states have implemented policies in order to safely address NOA concerns while attempting to limit adverse affects on projects in which NOA-containing rock will be impacted.

Virginia

Fairfax County has adopted a two stage approach for dealing with local NOA. The Fairfax County Health Department, Air Pollution Control Division (Fairfax APCD) oversees the potential public health concern associated with exposure to asbestos generated from construction activities. They enforce the Fairfax APCD Control Requirement Directives 1 and 2 for Construction Activities in Actinolite/Tremolite Soil Sources (CRD 1 and 2). The Virginia Department of Labor and Industry, Occupational Health Division (VDLI) regulates the interior of the construction site as it pertains to employee exposure under the Asbestos Standard, 29 CFR 1926.1101. These two agencies work in concert to control the emissions of asbestos fibers during work activities. The program is founded in the approach of proper disposal and capping of both the NOA source and constructed project. The following is a brief summary of CRD 1 and 2:

Directive 1 – Standards of performance for Actinolite/tremolite soil sources

1. Compliance Plan - A written compliance plan must be submitted to the Fairfax APCD for review and approval before work begins on the construction project.

2. Dust Control - Effective dust control must be practiced at all times.

3. Air Monitoring – Air monitoring must be performed during all phases of earthwork involving actinolite or tremolite containing material and comply with ambient air concentration standards for asbestos.

4. Disposal and Cap - An appropriate, safe, disposal site must be used to dispose of actinolite or tremolite contaminated soils whether they are to remain on site or be removed. All final disposal areas and the finished grade of the developed land shall be covered with six inches of clean compacted material.

5. Notification – Sufficient notice of asbestos shall be given to all employees and contractors on the site in compliance with the OSHA Asbestos Standard (29 CFR 1926.1101).

Directive 2 – Monitoring and Reporting Requirements

1. Monitoring requirements
    a. The monitoring and sample analysis will be conducted by competent personnel and closely supervised by an experienced individual certified with NIOSH 582 course training or equivalent [we should expound on that]
    b. Air monitoring samples will be collected.
    c. Project Reports of the perimeter, area, and personal monitoring results will be submitted to the Fairfax County Health Department.

2. Project Reporting Requirements
    a. A written description of the work activities.
    b. Diagram of the Construction Project.
    c. Air Monitoring Results.
    d. Violations to Directive 1 detected by air monitoring

3. A 24-hour average standard for asbestos ambient air concentrations is calculated

John Yetman was interviewed on the effectiveness of Fairfax County's NOA program, as well as public and commercial response. Mr. Yetman is a Senior Environmental Health Specialist with the Fairfax County Health Department, and has managed the county's NOA program for over 20 years. The NOA program described above has been in effect in Fairfax County since 1993. The NOA found in Fairfax County is typically beneath several feet of clay, so the program is designed exclusively for excavation and soil impacting activities. The soils of Fairfax County have been mapped, with known NOA encompassing 11 square miles of the 400+ square mile county. The geological maps are reportedly accurate to +/- 500 feet. If excavation/soil impacting activities are to occurring within this 11 square mile area, the contractor is required to submit a compliance plan as mentioned above.

The compliance plan describes location and activities associated with the project, dust control methods and worker and public safety controls. If the project is located within the NOA area per the soil map, the contractor is required to have a compliance plan approved through the county health department. If the project site is located within 500 feet of the mapped boundary, the contractor may submit a limited compliance plan which outlines the same requirements as the full plan; however, implementation of the plan is only required if suspect NOA is discovered.

Dust control consists primarily of applying water and/or slowing operations so that no visible dust is present. Air monitoring is required at all times soil impacting activity is occurring which consist of both area and personal sampling using PCM cassettes and analysis. The area monitoring is performed at several points on the perimeter of the "work zone", a term used to describe the area of the jobsite that has controlled access from the public. Area monitoring is a 24-hour average with the Fairfax County Air Pollution standard being 0.02 f/cc. Personal samples are also collected from workers inside the work zone to determine and 8-hour TWA with a maximum allowable fiber concentration of 0.10 f/cc. All air monitoring is required to be performed by a third party. All air monitoring results are required to be submitted in a final close out report; however, exceedences in airborne fiber concentrations are reported to the county health department immediately. Samples with elevated fiber levels may be further analyzed using Method 7402 which utilizes TEM to determine if the fibers meeting the PCM counting rules are asbestos.

Mr. Yetman explained that NOA-containing soils are encouraged to remain onsite; however, soils can be utilized as fill for other jobsites located within the known NOA area. If soils are removed from Fairfax County, it is strongly recommended the contractor inform the recipient of the possible contamination in the soil, and obtain a signature of acknowledgement.

Directive 1 also requires that 6 inches of clean cap be applied to all disturbed soils within the NOA area. Allowances are made when the soil is to be covered with vegetative-sod, in which case only 3 inches of cap is required.

Mr. Yetman felt that the program has been very successful for the county. He explained that the public and local contractors have become accustom to the NOA requirements, and they very rarely experience issues. He also noted that fiber level exceedences have become less common as contractors have developed effective means for dealing with dust suppression.

The "backbone", as described by Yetman, of Fairfax County's NOA management plan is the county soil map. This is an efficient way to identify if NOA will be a concern for the project, and if a compliance plan is required. Additionally, Mr. Yetman explained that the Health Department makes certain to explain the liability associated with removing NOA-containing material offsite, or outside of Fairfax County, which has seemed to reduce this occurrence.

California

The State of California Air Resources Board (CARB) has implemented regulations designed to significantly decrease the chances that asbestos in soil and rock can become airborne, and thus minimizing public exposure to asbestos. These state regulations are referred to as the Airborne Toxic Control Measures. (ATCM's) The first ATCM applies to surfacing applications and was originally adopted in 1990, but was amended in 2001. The second ATCM applies to construction, grading, quarrying and surface mining operations.

According to the CARB's Implementation Guidance Document for the Asbestos Airborne Toxic Control Measure for Surfacing Applications[47], the first Asbestos

ATCM prohibits the sale or use of restricted material for unpaved surfacing unless it has been tested and found to have an asbestos content that is less than 0.25 percent. The ATCM defines restricted materials as aggregate material extracted from an ultramafic (or ultrabasic) rock unit as shown on referenced geologic maps; ultramafic rock including serpentine; or aggregate material shown to have an asbestos content of 0.25 percent or more; or any mixture containing 10% ultramafic/serpentine materials.

The test method required to determine the asbestos content is either CARB Method 435 or a method approved by the CARB's Executive Officer. If restricted material is being sold or supplied for surfacing purposes, the producer of the material (quarry operator) is required to provide the recipient the following information: the amount of material sold or supplied; the dates the material was sold or supplied, sampled and tested; and a statement verifying that the asbestos content of the material is less than 0.25 percent. Anyone who sells or supplies restricted material, but did not extract the material from the ground, must provide all of the above information with the exception of the date that the material was sampled and tested. If restricted material is being sold or supplied for non-surfacing purposes the supplier must notify the recipient with a warning statement that the material may contain asbestos.

The amended ATCM contains the following surfacing exemptions:

- sand and gravel operations;
- roads located at quarries and mines;
- maintenance operations on existing roads;
- emergency road repairs;
- asphalt and concrete materials;
- landfill operations;
- results of a geologic evaluation;
- steep surfaces with limited access;
- surfacing applications in remote locations;
- roads located at construction sites; and
- riprap (material placed along water course or shoreline to prevent erosion)

The amended ATCM also allows the district authority to require geologic evaluation for the presence of rocks that may contain asbestos and the authority to require testing of any aggregate material for its asbestos content. This authority would typically be exercised if there is credible evidence indicating the potential presence of asbestos outside of an ultramafic rock unit.

There are two possibilities for the regions with mapped mafic or ultramafic rock, either the asbestos content is ≥0.25% or the asbestos content is <0.25. If the asbestos content is <0.25%, the material can be used for surfacing or any other use, if the material has ≥0.25% asbestos, its use is restricted. Minerals taken from mapped areas are restricted and must be tested and certified prior to use. In addition to mapped restricted areas the program includes a number of exemptions and has district authority to implement regional priorities. The 0.25 threshold was derived from the detection limit per the test method. Since only PLM 400 point count is required, if one fiber is observed in the counting area the sample has 0.25% asbestos. If fibers are observed outside of the counting area, the sample is reported as having "trace" amounts of asbestos present, and be considered <0.25% asbestos.

Any person who sells, supplies, or offers for sale or supply restricted material for non-surfacing applications must provide with each sale or supply a written receipt containing the following statement:

"WARNING!
This material may contain asbestos*.*
It is unlawful to use this material for surfacing or any application in which it would remain exposed and subject to possible disturbances.
Extreme care should be taken when handling this material to minimize the generation of dust."

Thus, NOA-containing material may be used for construction projects as long as the affected material is not to remain exposed. If NOA-containing aggregate is used for road construction, the dust suppressing method used, such as capping, must be designed to last for an extended period of time (ie greater than 5 years). Asphalt or concrete would suffice as an appropriate method, while water application or other short-term palliatives would not.

If an approved asbestos bulk test method has been used to perform two or more tests on any one volume of aggregate material, whether by the same or a different person, the arithmetic average of these test results shall be used to determine the asbestos content of the aggregate material.

The sampling frequency required for determining the asbestos content of any aggregate material is required to be the following unless the APCO approved an alternate testing frequency.

- Storage Piles and Conveyer Belts – Minimum of 3 random grab samples per 1000 tons
- Aggregate Covered Surfaces – Minimum of 3 random grab samples per
    - 1 mile of road
    - 1 acre of surface area
    - 2 miles or 2 acres of road shoulder

The second ATCM, which applies to construction, grading, quarrying, and surface mining operations was adopted in July, 2002. This ATCM requires more stringent dust control measures at these operations. For example, an approved dust mitigation plan may be required, depending on the size of the project, or proximity to a receptor such as a hospital, school, day care center, work site, business, residence or permanent campground. The requirements for road construction and maintenance differ somewhat from those for general construction and grading (e.g., development of a shopping center). Other requirements of the proposed ATCM address post-construction stabilization of disturbed areas. These areas must be revegetated, paved, or covered with at least three inches of non-asbestos-containing material. NOA-containing material may be transported if the loads are adequately wetted or covered with tarps.

According to the CARB's Regulatory Advisory: Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying and Surface Mining[48], the second California ATCM applies to road construction and maintenance, construction and grading operations, and quarries and surface mines when the activity occurs in an area where naturally-occurring asbestos is likely to be present according to currently published NOA maps. Areas are subject to the regulation if they are identified on maps published by the department of Conservation as ultramafic rock units or if the Air Pollution Control Officer (APCO) or owner/operator has knowledge of the presence of ultramafic rock, serpentine, or naturally-occurring asbestos on the site. The ATCM also applies if ultramafic rock, serpentine, or asbestos is discovered during any operation or activity.

Road construction and maintenance operations are required to use dust control measures for a specified set of emission sources and prevent visible emissions from crossing the project boundaries. California has local air pollution control or air quality management districts which must also be notified before any work begins. For construction and grading projects that will disturb one acre or less, the regulation requires several specific actions to minimize emissions of dust such as vehicle speed limitations, application of water prior to and during the ground disturbance, keeping storage piles wet or covered, and track-out prevention and removal. Construction projects that will disturb more than one acre must prepare and obtain district approval for an asbestos dust mitigation plan. The plan must specify how the operation will minimize emissions and must address specific emission sources. Regardless of the size of the disturbance, activities must not result in emissions that are visible crossing the property line. Quarries and surface mines must also obtain district approval for an asbestos dust mitigation plan which must address specific emission sources. In addition, they must meet specific opacity standards for certain types of equipment and ensure that there are no emissions visibly crossing the property line.

Records related to the applicability of the regulation or compliance with the specific provisions of the regulation or the asbestos dust mitigation plan must be kept for seven years. The results of any air monitoring or bulk sampling required by the district, any bulk sampling to document the applicability of, or compliance with, the regulation, and any other records specified in the dust mitigation plan must be reported to the district.

The second ATCM has the following exemptions:

- Homeowners and tenants working on their own residential property

- Agricultural operations and timber harvesting
    - Except for the construction of roads and structures in connection with agricultural and timber operations

In addition, districts may grant an exemption under any of the following conditions:

- A geological evaluation demonstrates that ultramafic rock or serpentine is not likely to be found;
- Road construction and maintenance activities in a remote location;
- The processing of rock from an alluvial deposit.
- For emergency road repairs, district notification may be delayed.

CARB's Manager of Emissions Evaluations, Robert Krieger, provided feedback on California's NOA regulations. Mr. Krieger explained that while the state of California has developed the ATCM's, it is the responsibility of the local air pollution district authority to implement and regulate, and the districts have the option of placing more stringent requirements than the ATCM's. While asbestos has several definitions, California has taken a conservative approach that any asbestos exposure is harmful, thus the ATCM's designed to reduce or eliminate asbestos exposure to the public; consequently, imposing the 0.25% standard. Additionally, districts can implement air sampling requirements for projects encountering NOA; the ATCM does not address air monitoring requirements.

Mr. Krieger mentioned that historically when NOA was discovered on a school's property it had been removed. More recently, however, this practice has been determined to be costly and unnecessary. If NOA-containing material is found to be on a school's property, or is used as fill during a construction project, it must be covered with a minimum of 12 inches of clean fill. Projects not on school grounds where NOA-containing material is used a 3 inch layer of clean fill is required.

John Clinkenbeard, a Certified Professional Geologist (C.P.G.) for the State of California, explained the USGS has developed geological maps of the entire state of California available at 1:250,000 resolution. At this resolution, a boundary line on the map is approximately 1,000 feet wide and the smallest area resolution is 25 acres. When the local district authority reviews a construction permit, they reference these maps to evaluate if the proposed project site falls with in areas of known ultramafic or serpentine formations, or an area with known asbestos present. If the project is to occur in an area of concern the ATCM applies. If the project area is outside of the known areas of concern, the project site must undergo a geological evaluation by a third party C.P.G. Evaluations are also used when the project location is close to the boundary line, or the Contractor believes that asbestos is not present. California is presently working on increasing the statewide geological map resolution to 1:100,000; however, this project is not anticipated on being completed for several years. Some districts have funded mapping efforts in order to obtain a 1:24 map resolution.

After discussing NOA in Alaska, Mr. Clinkenbeard referenced Airborne Visual Inferred Spectroscopy (AVIRIS) as a possible geological mapping option. Imaging spectroscopy is a new tool that can be used to map specific materials by detecting specific chemical bonds. As a result it is an excellent tool for environmental assessments, mineral mapping and exploration, vegetation communities/species and health studies, and general land management studies.[49] The AVIRIS technology is aircraft-mounted and can collect data at a rate of 2 square kilometers per second. While this technology may not be feasible for Alaska's entire landmass, project specific uses may prove to be beneficial.

Jeff Wright with the CARB was contacted regarding M435 asbestos testing. The M435 method was developed in 1990 and was designed to detect serpentine asbestos in gravel/soil. The ATCM's requirements result in a large quantity of soil and gravel being tested for the presence of asbestos per M435; therefore, many testing laboratories throughout the state perform this analysis. CARB performed an interlaboratory study of California laboratories which offered the M435 testing. Samples were "spiked" with a known amount of asbestos and sent to the labs for analysis. The results of the study indicated vast discrepancies in the sample results.[50] All the laboratories included in the study were national accredited to analyze asbestos, however; M435 is unique from other test methods and while all the labs where adhering to M435 protocol, several different varieties of milling and homogenizing equipment was used. Mr. Wright explained that increased sample pulverization has been known to decrease asbestos concentrations via PLM analysis because the fibers are reduced in size to the point where they no longer meet the definition of a fiber; in contrast, asbestos concentration results per TEM analysis tend to increase. Because NOA is typically not uniform in samples, after the material has been milled sample homogenization should occur. PLM analysis examines only a small fraction of the sample, and TEM examines approximately one millionth of that, making homogenizing the samples an extremely important process.

Mr. Wright explained that California is in the process of undergoing several changes to M435. The proposed changes are as followed:

- Sampling
    - Bias field sampling per the discretion of the C.P.G.
        - Perform "target sampling" which focuses on areas or materials most likely to contain NOA opposed to "random" sampling in which the NOA may not be sampled
- Processing
    - Formulate a M435 accreditation for testing laboratories
        - California is working with NVLAB to develop an M435 accreditation

        - Require specific equipment to be used for the pulverizing and homogenizing processes
- Analysis
    - Move away from quantitative analysis
        - Results would be reported as “present” or “absent”
    - Additional analysis
        - If PLM observes no asbestos, require the sample to be analyzed via TEM

Other States

The following states either have, or are in the process of implementing NOA regulations: Massachusetts, New Hampshire, Pennsylvania, and Texas.

NOA CONTROL STRATEGIES AND TECHNOLOGIES

The following are a number of NOA control strategies and technologies that can be used to ameliorate asbestos release from NOA and NOA-containing material. After presenting some general information generated by the federal EPA, the items are divided into manage-in-place, dust suppression methods, covering or capping, and road maintenance. Finally, long term maintenance requires some public education.

EPA Facts Sheet: Methods for Reducing NOA Exposure[51]

Below is a list of methods recommended by the EPA to reduce asbestos exposure resulting from NOA. These are general methods, and must be applied on a project-specific basis:

- *Wet road surfaces with water using trucks, hoses, or sprinklers*
- *Wet piles of excavated material and cover them with tarps, plastic sheeting, or other items*
- *Continuously mist the work area*
- *Install wind barriers around the work area*
- *Clean or decontaminate equipment and vehicles to ensure that no equipment or workers track soil out of the work area (a gravel pad, tire shaker, or wheel wash system may be used to clear soil from vehicles)*
- *Wet the work area using a spray system attached directly to rock cutting or drilling equipment, such as a fine-mist sprayer or a variable-rate fogger nozzle*
- *Excavate utility trenches to an adequate depth and backfill them with clean soil so that future repair work will not need excavation into potential NOA-containing materials*
- *When transporting NOA-containing materials, avoid overloading trucks; keep the material below the top of each truck compartment and cover material with a tarp*
- *Limit personnel and vehicle access to the work area*
- *Identify NOA-containing areas with signs*
- *Reduce driving speed*
- *Reduce drilling or excavating speeds*
- *Excavate during periods of calm or low winds*

Roads and Parking with NOA in place and for unpaved roads and parking areas:

- *Cover roads with non-NOA-containing rock, chemical sealants or dust suppressants, chip seals, limestone aggregate, petroleum sealants, or asphalt cement paving*

- *Wet road surfaces with water*
- *Install windbreaks or berms*
- *Reduce driving speed*
- *Avoid dusty areas, especially in windy conditions*

And throughout communities:

- *Cover areas of rock and soil with clean soil, rock, vegetation, or other material*
- *Pave over unpaved walkways, driveways, or roadways containing NOA*
- *Landscape areas with vegetation, such as NOA-tolerant plants, and add a layer of organic mulch or NOA-free soil. Water plants often until they are established to minimize erosion*
- *Water garden areas before digging*
- *Keep windows and doors closed on windy days and during periods when nearby rock or soil may be disturbed, such as during construction*
- *Limit track-in by using entryway (door) mats, and wipe down pets before they enter buildings to reduce the amount of soil tracked indoors*
- *Allow children to play in outdoor areas only if the area has a ground covering, such as wood chips, mulch, sand, pea gravel, grass, asphalt, shredded rubber, or rubber mats*
- *Relocate outdoor activities to areas that do not contain NOA (walk, run, hike, and bike only on paved trails)*
- *Avoid dusty areas, especially in windy conditions*

Manage In Place

The ideal method for managing NOA material is in place and undisturbed; especially if the NOA material is not exposed. Fairfax County, Virginia, for example has a large NOA deposit which exists beneath non-NOA material. Unless this material is required to be impacted through construction or other activities, Fairfax County has taken the position to leave the material in place. NOA does not pose a health risk if it remains in a location where asbestos fibers cannot become airborne; such as beneath non-NOA material.

Separation

A variation on manage-in-place is to separate the NOA from associated non-NOA materials. Separation and excavation of the NOA materials for a source of gravel aggregate might serve as a control method, if the locations are known and the amounts are small. However this method seldom practical, since NOA deposits commonly extend miles, if not hundreds of miles. Excavation is generally only utilized as amelioration method when soils with known NOA are required to be impacted for projection such as road and building construction and utility work. Excavation requires the disturbance of the NOA, hence the potential for airborne exposure.

Dust Suppression

If NOA material is required to be disturbed, dust generating activities should be limited at all times. The most common engineering control used to reduce dust levels, hence airborne asbestos exposure, is the use of water and/or wet methods during NOA-related activities. The following is a list produced by the EPA of engineering and work practices that reduce exposure to NOA on excavation, grading, or utility work at construction sites.[51]

Reducing Vehicle Traffic and/or Speed

Dust emissions from unpaved road surfaces are directly proportional to the number of vehicles traveling on it, thus, reducing the amount of traffic will in turn reduce the amount of dust generated. By implementing weight or use restrictions on vehicles traversing the unpaved road could significantly limit the amount of traffic on a NOA-containing unpaved road and in some circumstances it may be possible to remove an unpaved road, or section of road, from service to the general public. An example of this type of control was recently imposed by the City of Kotzebue, in an effort to reduce particulate matter smaller than 10 microns in diameter (PM_{10}) emissions, where anyone under the age of 14 is prohibited from operating off road vehicles on city streets unless accompanied by an adult on the same vehicle.[52]

The rate at which a vehicle travels on an unpaved surface is also proportional to the amount of dust generated[53] meaning the efficiency of speed reduction as a dust control measure increases as the speed is reduced. For example, if the base speed is 40 miles per hour, a reduction to 20 miles per hour results in a 65% reduction in dust emissions; a further reduction to 15 miles per hour results in an 80% reduction in dust emissions.[54] Vehicular speed reduction can be achieved through posted signage coupled with enforcement and/or roadway manipulation such as speed bumps. The initial implementation of both these methods would be minimal, with immediate results. Major costs associated with these methods include increased travel time and additional law enforcement. While enforcement of these methods may be difficult in some rural Alaska communities, it may be a very practical, enforceable and effective for reducing airborne asbestos at quarries, construction sites and more densely populated areas.

In a best case scenario, at optimal conditions, both of these control methods would still not address the issue of exposed NOA on the roadway. Substantial amounts of dust would still be produced during dry conditions and natural elements such as wind would continue to make asbestos airborne. In most situations, these methods should be either approached as interim responses, or used in combination with other methods.

Water Application

Federal regulations require the use of ”wet methods” when impacting ACM's which have potential of releasing asbestos into the air. Due to the moisture, particles/fibers adhere to each other through the surface tension of connecting water droplets and the adhesion of droplets to particles/fibers reducing the amount of emissions released during impact. The same principle applies to NOA-containing unpaved road systems; if they remain wet, dust emissions will be minimal. The easiest and most effective way to accomplish this is direct application of water to the surface of the roadway.

A large water source exists in most communities throughout Alaska. While more heavily populated areas have the required means to extract and apply water in sufficient quantities, many smaller communities do not. Often times some form of water application system can be implemented; however, may be too laborious to continue for long term.[55] In Amber, for example, no water trucks or large tanks were available for water application on so a simple gravity feed system was utilized. This system consisted of 4 - 275 gallon interconnected square plastic containers (totes) placed in the back of a truck which were filled with water from the Kobuk River and attached to a perforated pipe on the back of the truck.[37]

Applying water to surfaces provides effective, but short-term reductions in dust generation with water typically needing to be re-applied ever 0.5 – 12 hours depending on temperature and humidity. It has been determined that regular, light watering is more effective than less frequent, heavy watering.[55]

If the necessary equipment and water source are available, wetting unpaved surfaces can be greatly reduce dust emissions while remaining cost effective. Additionally, if wetting were coupled with one or both of the traffic control methods, evaporation from the roads surface would occur slower and dust emissions would be lower yet. Continuing costs would include equipment maintenance and workers performing the application. If equipment is not available, start up costs could be significant. Wetting is a practical control method to be used as a construction project control method or a short-term solution. Due to water having to be continuously applied to keep the surface moist, alternate long term control strategies should be investigated.

Increasing Moisture Content

The application of deliquescent salts such as calcium chloride, magnesium chloride and sodium chloride (common rock salt) are also implemented as dust control methods. These salts absorb moisture from the atmosphere and when mixed with surfacing soils will keep the treated soils at higher moisture content than untreated soils. For example at 77ºF and 90% humidity calcium chloride will absorb more than 17 times its own weight in water.[53] Potential disadvantages to the use of these salts are that roads may become slippery when wet, vehicle corrosion may occur and roads may become more susceptible to freeze and thaw damage. Additionally, salts applied for dust suppression initially penetrate the roads surface several centimeters, followed by a gradual rise to the surface by capillarity action, making them susceptible to being washed off by rain. Prolonged rainfall will leach the salts from the roadway, potentially impact groundwater and surface water quality, and attract wildlife potentially causing safety concerns. Typically if the proper buffer zone exists between the water and the treated area, water quality impacts will remain minimal.[54] The practical utility of an application of one of these salts is no more than one year.[53] Sodium chlorides generally considered less effective than either calcium or magnesium chloride. Application of these materials is generally required 1-2 times per season.

Several locations in Alaska have utilized calcium chloride for dust control in recent years including Kotzebue, Teck Cominco's Red Dog Mine, and Haines, among other locations.[53] Environmental impacts of chlorides include metal corrosion, and degradation to nearby vegetation, surface, groundwater, and aquatic species.[53] In addition, because calcium chloride can substantially lower the freezing temperature of water, concentrations of the palliative in road soils can change the thermal stability of these soils.[53] This could potentially create issues in areas where extremely heavy loads are forced to wait until the road has completely frozen in order to supply adequate reinforcement such as on the Dalton Highway.

Covering or Capping of Installed NOA

Another common engineering control is to place a cover system (or cap) over the NOA. These materials may include non-NOA soil or rock, concrete, chemical sealants or dust suppressants, chip seals, limestone aggregate, petroleum sealants, asphalt paving, geotextiles, wood chips, mulch, sand, pea gravel, shredded rubber, rubber mats, and vegetation. Several factors, including cover material properties and site characteristics, affect the type of cover system appropriate for a particular area.

Palliatives

The majority of palliatives used on unpaved roads and airfields consist of chemicals designed to bind soil particulates together, formeing larger particles less likely to become airborne. Petroleum-based binders, organic nonpetroleum dust suppressants (lignins), electrochemical stabilizers, synthetic polymer products and pozzuolannic minerals comprise the main palliatives and our discussed further below:

Petroleum-based binders used as capping materials for dust suppression include emulsified asphalts, cutback asphalt (liquid asphalt), dust oils and modified asphalt emulsions.[55] These products are applied to the surface soil as a thin layer of asphalt which binds the soil particles together, consequently waterproofing the road as well. Some binders increase the mass of fine particulates, instead of binding particles together. Both variations result in decreased emissions. When asphalt is used to bind particles together, the emulsified asphalt, because it is a mixture of asphalt and water in very small droplets, has the capability to penetrate unpaved road surfaces to coat more than just the surface particles, especially if the product is mechanically mixed into the top inch or two of road surface with a grader. Petroleum-based binders that contain fractions of lighter solvents, and especially those containing polycyclic aromatic hydrocarbons (many of which are carcinogens), can contaminate waterways if any migration of these lighter fractions occurs due to runoff.[53]

Organic non-petroleum dust suppressants include lignosulfonates, resins, and vegetable oils. Lignosulfonates originate from lignin, a complex compound which binds wood cells together as a natural polymer. Most commonly lignin is derived from wood fibers during paper manufacturing. Lignosulfonates bind surface soil particles together due to a combination of chemical and physical interactions. Lignosulfonates are known to greatly increase dry strength under dry conditions and retain effectiveness through extended dry periods. Generally 1-2 applications of lignosulfonates are required per season. Lignosulfonates are water soluble and will leach out of, or deeper into, roadway surface with rainfall and may become partially or totally destroyed.[55] These products are also corrosive to aluminum and its alloys unless calcium carbonate is added. Glacial tills contain low levels of clay and have low plasticity; consequently, lignosulfonates may be of limited value in controlling dust emissions from these soils. Furthermore, because lignosulfonates are derivatives of sulfuric acid, leaching may adversely impact watershed areas by affecting the acidity of water sources. Lignosulfonates are reported to not bind well on roads that had been treated previously with chloride compounds.[56]

Electrochemical stabilizers include sulphonated petroleum, ionic stabilizers, and enzymes. These products are intended to neutralize the ionic charges of clay-sized particles, thereby allowing electrostatic forces to bind the particles. Electrochemical stabilizers are generally effective regardless of climatic conditions.[55] To be effective, electrochemical stabilizers need to be worked into the road surface, requiring equipment that may not be available in remote rural communities. The performance of this material is dependent on fine-clay mineralogy which is unlikely to be encountered in most areas of Alaska.

Synthetic polymer products include polyvinyl acrylics and acetates that bind soil particles together and form a semi-rigid film on the road surface. These products are found as either a water soluble liquid or a powder intended to be mixed with water. Because synthetic polymer products are almost exclusively applied as a liquid, the material takes approximately 12-24 hours to cure during which time traffic should be kept minimal on application surfaces until the curing process is complete. Additionally, the product should be applied during a time of year when temperatures will not approach freezing, otherwise the curing process will not work. The synthetic polymer products “Durasoil” was used as the dust suppressant in Ambler, as well as many other unpaved runways throughout northwest Alaska.[37] Synthetic polymer treatments are generally required once every 3-5 years.

Pozzolanic minerals, such as lime and cement, are typically added to non-plastic road surface material to produce a thin crust by agglomerating with fine dust particles. These stabilizers must be field mixed into the road material and compacted. These surfaces do increase the dry strength of material under dry conditions; however, once hardened it cannot re-harden if disturbed by abrasive forces, such as some off road vehicles and grading. Generally treatment with this method is applied once every ten years.

Gravel Replenishment

Asbestos-containing dust emissions from unpaved surfaces can be reduced by the addition of several inches of non-NOA containing gravel. This action would reduce the concentration of NOA on the surface; therefore, reduce the rate at which asbestos is allowed to become airborne.[57] Gravel provides a hard-wearing surface that shields underlying NOA from the abrasive forces of vehicle wheels. Traffic causes abrasion between the NOA and non-NOA aggregates, however, which over time creates fine dust. The degradation is somewhat dependent upon the hardness of the aggregate. Newly applied gravel will not reduce the strength of vortex airflows behind passing vehicles from entraining loose soil particles into the air. If the road-base is not well-constructed using crushed aggregate, surface gravel will be pushed down into the road surface by traffic, especially during wet conditions. If the road surface does not contain enough fine material of high cohesion to hold surface gravel in place, traffic can also cause surface gravel to be expelled laterally from the road’s driving lanes. To be effective over more than a short period of time, new gravel applied to a road should be anchored to the road surface by incorporation into a cohesive surface layer through either well-graded aggregate mixes or by the use of soil adhesives (i.e., palliatives).[53]

In the event the newly applied gravel is lost to the roadway surface through vertical migration into non-cohesive soils, the use of geotextile fabrics may be of benefit. These fabrics are constructed of polymer threads that are very high in tensile strength, and are available in designs that either form.

Paving

Paving includes a variety of surfacing materials with the three general types being bituminous concrete, concrete and chip seals.

The most effective, and expensive, method currently available to control dust emissions from unpaved surfaces is the application of pavement or other durable materials to the road surfaces. Bituminous or Portland concrete provide durable surface which prevents the abrasion of underlying soils. Bituminous concrete is a hot mixture of asphalt and well-graded aggregate, while Portland concrete is a composite material of cement, water and aggregate. Concrete requires less maintenance and is considered more durable than bituminous surfacing. Both methods are designed to support heavy traffic and unless the roadway typically carries 250 to 500 vehicles per day, the use of either of these paving options will likely not be cost effective.[55] Kotzebue has several roads which typically meet this "traffic quota" on a daily basis, and recently have had some of the main roads paved.[53] These forms of paving are not typically used on secondary roads, and would virtually never be considered for rural Alaska.

Chip seal surfaces, also called macadam, consist of one to three layers of aggregate and asphalt. Asphalt is sprayed over each aggregate layer as it is applied. After all the aggregate layers are in place with asphalt being applied over each individually, a covering of smaller stones is placed on top and then the entire system is compacted with the finished chip seal typically being 1 to 4 cm thick. Applying chip –sealing to an NOA-containing unpaved road would reduce dust emissions into the atmosphere because the chip sealant would bind the surface material. Annual dust control efficiencies of paved surfaces have been estimated by researchers to range from 90 to 99.9 percent.[57] A standard three-layered chip surface at 3.75 cm would be expected to last 10 years before additional surface treatment is required. Most chip seals require a second coat after 1 year and a third in approximately five years.

Durable Surfacing Materials

Fiberglass plates are used in cold climate oilfields to provide temporary road surfaces over native soil. These interlocking plates are typically manufactured in sections that are 14 feet long by 8 feet wide by 2 inches thick. The plates are designed to carry very heavy loads over short distances without the need to construct structural roadbeds in areas like northwestern Alaska, where construction aggregate is in very limited supply. The plates are expensive, costing about $2,000 per plate, but appear to have a significant lifespan.[58].Some questions exists, however, as to whether such plates are skid resistant at the vehicle speeds typical in rural communities.

Road Maintenance

The effectiveness of any dust suppressant applied to a road surface depends upon many factors such as type of road, traffic, intended uses climate, type of dust suppressant, drainage, and available maintenance resources. These factors must be considered together in the proper maintenance of a road that will safely and cost-effectively resist dust generation. For example, if the road surface is not well drained, water will puddle either on the road surface or in adjacent low spots. Standing water will float soil fines to the surface and distribute them across the roadway surface with passing traffic. Standing water adjacent to a roadway has the potential to saturate the road sub-base, resulting in structural failure as evidenced by potholes. Aggregate in a roadway surface reduces tire forces on fine materials that increases the release of dust from a roadway. The loss of fines in the roadway surface leaves the aggregate unanchored and vulnerable to being pushed to the side of the road by tire forces. The success of palliatives to reduce dust depends on the repair and maintenance of good drainage on and adjacent to the road.[53]

Control Strategies for long term management of in place NOA.

Education

In rural communities throughout Alaska, the availability of law enforcement to assist in applicable dust suppressing methods is likely to be limited or non-existent. Imposing speed limits and vehicle use restrictions in these communities will be most effective if the residents of the community understand their purpose. Education about NOA and its potential health effects is a vital step in obtaining local support for any control method used. Education techniques for NOA-affected areas may include advertising, public meetings, information packets and making available NOA-knowledgeable experts. If residents understand the reasons for implemented controlled methods in their communities, a positive local response can result in social pressure applied throughout to adhere to new policies for the well-being of the community as a whole.

Residents in areas with geology favorable for NOA formation should be educated in basic NOA knowledge. In rural communities with a known NOA issue, such as Ambler, where airborne asbestos fibers from NOA are likely to be present, NOA general housekeeping and personal hygiene techniques should be implemented which requires specific education efforts. Education efforts could be carried out through State agencies or consulting firms with knowledge and experience with NOA. The cost for this effort would include travel to the subject community, preparation of materials (information packets) and potentially on-going assistance as new issues develop; however, these costs will be minimal considering many control methods are dependent on community support. If residents are unwilling to comply with newly imposed policies, any control method is likely to fail or have minimal effect.

Workers and the general public need to be properly educated regarding general housekeeping and persona hygiene practices appropriate for locals with NOA exposure potential. This control technologies include:

- Routine hand and clothes washing
- Boot/shoe removal at work and home
- Wet wiping and/or HEPA vacuum of visible dust accumulations as they develop
- Wet methods
- Controlling or avoiding visible NOA dust

Analysis with Discussion

Introduction

The asbestos standards, such as the training requirements for asbestos workers, were written on the premise of encounters solely in manufactured products. While the EPA has developed several documents to help increase knowledge and prevent exposure resulting from NOA, no Federal regulations have been implemented. This has resulted in several states implementing their own set of regulations and guidance documents. However, of the 20 states where NOA is known to exist, only a few have, or are beginning to, implement NOA regulations. The remaining states (such as Alaska) deal with NOA on a project-specific basis which typically exhibits substantial project delays and increased costs.

While there are limited general recommendations (see EPA NOA dust guidance), recommended NOA amelioration methods need to be selected on a site-specific basis because the exposure is dependent on a vast number of variables related to site specific conditions and work practices chosen for processing/handling. The single most important goal for almost all NOA-containing sites, materials, and systems is to prevent asbestos fibers from becoming airborne to eliminate respiratory exposure to asbestos. Several methods have been utilized to achieve this goal, with the main options being: manage in-place, dust suppression, cover or cap, and excavation/removal of NOA-containing material.

It is clear that gravel sources with NOA are present in Alaska and they have the potential to affect public health, project development and costs. At the same time it is well documented nationally and with Alaskan experience that use of proper NOA control strategies allow the safe employment of NOA materials. While past project experience in Alaska has not documented significant exposure or post project health concerns, NOA has been costly to some projects. This was primarily due to lack of advanced knowledge of NOA's presence, failure to characterize and notify, which resulted in changed conditions and non-competitive contract modifications after the contract has been awarded. Even if NOA is known during the project planning stages, the best course of action may not be clear because there are professional NOA geologic, risk and regulatory interpretations and definitional issues that will generate discussion and require resolution. The successful implementation of a NOA program will therefore require development and needs to involve training and transition for all involved including state, regional corporations, private resource owners, project designers, contractors, operation and maintenance staff, community and local residents.

Resource owners need to better understand their resource, develop the knowledge and marketing expertise to have it properly characterized and categorized for appropriate uses. Designer's need to develop the necessary project specifications requiring resource certification as well as contractor training and experience. Successful contractors need to learn how to develop competitive work plans for safely utilizing NOA materials on project specific basis. For both companies and citizens in affected areas these changes include learning about the hazards and taking personal responsibility for controlling or avoiding activities creating airborne visible dust as well as implementing life style and work practice changes involving life style modifications such as housing/office boot/shoe removal, utilization of wet methods and HEPA filtration for routine cleaning of visible dust accumulations.

Liability

The liability of ADOT and suppliers of NOA materials may be divided into three:

1. Tort liability to individuals and organizations,
2. Contractors have additional liability to protect their workers and the public from the contractor's operations, and
3. Legal liability to agencies for failure to follow applicable laws and regulations.

Tort

If the ADOT's use of NOA damages an individual or organization, ADOT may incur tort liability. For example, if a resident of a village downwind from an ADOT airport that used NOA in the runway were to die of a disease known to be caused by asbestos exposure, the victims family might sue the ADOT. Although it takes years of heavy asbestos exposure to cause those diseases, and for most asbestos diseases asbestos is a "risk factor" not the sole cause, there are other causes, most notably smoking, sympathetic juries frequently find for the plaintiff, almost regardless of fault. Due to the tort reform movement, Alaska's current tort laws have reduced the windfall aspects of such suits, but they are certainly possible. Here we can suggest little except developing good standards for use of NOA, having review by all agencies concerned with health and environmental safety, then strictly documenting conformance. Such defensive practices will not make such suits impossible, but will make their defense much easier.

The owners of NOA materials sites face essentially the same tort issues as the ADOT. The question if this liability can be handed off from the owner to the ADOT is one that requires legal advice. California has a system of notification and paperwork that would seem to hand that liability off to the purchaser of the materials. We do not know if this has been tested in court. We doubt the CARB has the legal authority to change the state's tort laws. However, as above, conforming to established procedures is often a strong defense.

Contractors' liability

The contractors' liability to follow the state's labor laws regarding occupation health and safety are fairly straight-forward, if the NOA is mentioned in the project bid documents. The contractor's liability to third parties, such as the public, may be more complicated. The contractor's general liability insurance will defend them; however the contractor's insurance company will then try to recover from the state and/or the material owner. This may be forestalled by appropriate contact terms regarding insurance, but clearly this is a item for expert risk management and legal advice. Finally, if the specifications do not make clear the need to get certain permits and the contractor's operations are impacted, the contractor may try recover from the ADOT for defective specifications.

Liability for laws and regulation compliance
CERCLA and RCRA deal with *wastes.* NOA is not a *waste* thus mining and incorporation of NOA does not come under either of those laws. However, for example, if the NOA mining segregated some materials that had a lot of asbestos from other materials, and thus had small mounds of asbestos materials on the site, might these mounds be waste piles? Here the regulatory standard is 1% asbestos, so if the mounds had less than 1% asbestos, they would not be asbestos under the CERCLA or RCRA regulations. Here the authors have not obtained further clarifications regarding mining and mine waste. While this would be the responsibility of the owner of the NOA materials site, these clarifications should be obtained in the next phase to enhance communications between the ADOT and the material site owners.

California Experiences

The California NOA regulations do address many issues and procedures that may bear on liability. The California NOA regulations separate the "notice requirements" into two categories; material intended for surfacing, and material not intended for surfacing. In addition to the notification variations, material intended for surfacing must have an asbestos content of <0.25% asbestos per the CARB 435 analysis, unless the surfacing application is considered one or more of the 11 surfacing ATCM exemptions. These notification requirements are intended to both "hand-off" liability to the purchasers and produce adequate documentation. (Signage and placard requirements for regulated material are intended more to prevent accidental misuse and/or handling than for recordkeeping or proof of receipt.)

Once the NOA-containing material is in the possession of the purchaser, it is their responsibility to provide adequate protection and training to the employees which handle the material. The end-use of the material is also the purchaser's responsibility at this point. They must insure they not only adhere to all OSHA, EPA, State and Local requirements during handling and transport, but also to their approved site specific Work Plan. The purchaser must also insure the material is approved by the regulating agency for its intended end use. Often the end use of the regulated material will managed by a third party where they would be in responsible charge of obtaining approval, permits, etc., for the materials end use and any required dust control strategies (capping, paving, etc.).

Resource owners and contractors have raised liability concerns regarding the sale and use of NOA materials. In some instances it is understood litigation may already have been filed against NOA resource owners for the sale and use of NOA materials. This is a real concern that if not properly understood and addressed will impact the safe use of NOA materials and create unnecessary project costs. CERCLA Section 9604 provides for resource owner protection against naturally occurring hazards. Liability for resource processors and/or contractors can be addressed through their compliance with NOA program requirements. It is not possible to prevent all lawsuits and particularly frivolous filed cases. Therefore the effectiveness of the recommended NOA program to be developed will likely be tested legally and provide court interpretation and resolution of liability concerns.

Ambler, for example, is a unique case which would not completely comply with any of the existing 11 surfacing exemptions or the Construction, Grading, Quarrying and Surface Mining ATCM for California. While California's state NOA regulations are undoubtedly the most developed in the United States, it is unlikely the drafters/authors were required to take into account communities such as this. Had similar circumstances existed, certainly specific exemptions would have been established to address this. Alaska can look to, and even adopt, the California NOA regulations; however, scenarios exist in Alaska unlike anywhere else in the United States, and special provisions and/or exemptions will be a necessity of this future rule.

Examples of Liability

In the Swift Creek Washington case where NOA-containing Sumas Mountains would periodically experience landslides which flowed into the Swift Creek River where the material was dredged and staged along the shoreline to prevent flooding. There was no organization deemed the Responsible Party, and several federal, state and local agencies are currently involved in the Swift Creek NOA concern. It was determined that the EPA Superfund program had limitations on spending money on this type of cleanup because the material of concern was naturally-occurring. This makes NOA sites exempt by law from the EPA Superfund program, except where the material was moved by unnatural forces (ie construction, dredging). This caveat allowed the EPA to use funding to assist in the Swift Creek NOA concern.[60]

Libby, Montana, which has been declared an EPA Superfund site, has had ongoing federal cleanup efforts since 1999. In this case, processing mined vermiculite constituted the majority of the contamination; consequently, the asbestos was not viewed as naturally-occurring. In 2003, in a ruling issued by the District Court of Montana, the court said the mining company, W.R. Grace, was liable for costs related to the investigation and cleanup of asbestos contamination in Libby and ruled that the EPA's revised method for calculating indirect, or overhead, costs is appropriate and that those costs may be recovered from W.R. Grace. The ruling meant W.R. Grace was responsible to pay all of the $54.5 million in costs that the EPA incurred through December 31, 2001. Costs incurred after that date were to be resolved in future proceedings if disputed by

W.R. Grace. In May, 2009, W.R. Grace and three individual defendants were acquitted of criminal charges under the Clean Air Act alleging they conspired to conceal the health dangers posed by the contamination.[61]

NOA proposed for use

While NOA materials are known to be present in 20 of the 50 states, only a handful are moving ahead with implementing NOA regulatory control policies. Those states that have implemented NOA regulations have focused their programs on:

- Geologic mapping of “restricted” areas with materials likely to contain NOA
- Compliance level characterization of NOA free materials based on the limit of detection of less than 0.25% asbestos content
- Asbestos characterization sampling for use of materials from restricted areas
- Utilization Compliance Plan Submittal, Review and Approval
    - Source, transport route and work product
- Providing local authority to interpret program requirements site specifically and implement additional testing where necessary.
- Development of necessary program exemptions
    - area wide
    - regional

While education and training with regards to NOA exposure, work practices, and safe uses is key to any program, the submittal and approval of site specific compliance plans for approval by local authorities will insure the long term viability of an effective “living” program for that project’s NOA.

NOA site specific work plan might note the availability and cost of NOA-free material as those affect project design options. Control technologies that eliminate or reduce exposure pathways might minimize individual project costs. The remoteness of many Alaska projects and absence of alternative transportation routes may require reasonable exemptions, based on a balance of benefits and risks.

Similarly, the concentration and variety of NOA will play a major role in determining the most cost effective control strategies. While federal regulations are indifferent to the form of asbestos, control methods for NOA should not be. Forms of asbestos that break apart and easily become airborne should be held to a higher standard than those which are tightly bound within a rock matrix. This highlights the importance of developing a consensus standard as well as mapping and sampling efforts to properly characterize specific asbestos materials present as well as the risk. The authors recognize this may be quite difficult in practice, but certain broad guidelines are possible and these may help project planners and designers.

NOA in place - control technologies

NOA control methods should start with the least expensive options first. In general terms there are four control methods: education, wetting, palliatives, and capping.

By itself and together will all the other control methods educational outreach to the staff, industry and general public regarding the hazards and methods of controlling or avoiding airborne dust is almost always advised. Outreach such as encouraging implementing speed controls and restrictions on vehicle use in sensitive areas (i.e., near schools, hospitals, and residential areas) and modifying life style habits to reduce personal exposure are all worthy of consideration.

If a road base lacks adequate drainage, the embankment will be weak and the effectiveness of dust control measures will be limited. Reconstructing unpaved roads to provide good drainage and a solid base is needed for dust palliatives, capping with clean material, or paving to be effective. If the road soils are of poor quality, geotextiles may be a feasible option to add support to the road surface. According to Succarieh,[54] expert professional advice about the road is often needed. The ADOT Local Technical Assistance Program (LTAP) may assist As part of the educational program it is recommended that the ADOT LTAP enhance their NOA knowledge and resources for distribution.

If sufficient equipment and manpower is available, watering roads during high dust periods should be performed; however, this is a short-term effective method of dust control and more long-term control methods should be investigated. Historical monitoring data illustrates that high dust generation rates are greatest during the two-month period following breakup, therefore, short term control measures like watering can provide limited benefits if impacted communities have access to watering equipment.[54]

Another control technology is application of dust palliatives. In order to obtain the greatest benefits from the application of dust palliatives, site-specific investigations of local traffic and soil is required. Investigations should begin with an assessment of the soils used to construct and surface the unpaved roads. The ADOT's LTAP, may assist rural communities with technical assistance and/or training on proper techniques for soil analyses useful in the palliative selection process. [54]

Some deliquescent salts and/or synthetic polymer products may provide adequate levels of dust control on unpaved roads. Again this depends heavily on the soil and traffic conditions in the respective community. These products have been tested in several locations in Alaska and have been demonstrated to provide varying control of dust emissions. Because the successful use of these products is dependent upon a number of factors that vary from community to community, pilot tests of selected products for a summer season should be undertaken in affected communities before community-wide application is pursued. [54]

Contractor Feedback

Approximately 150 contractors in California who likely encounter NOA were contacted via email and asked to provide general feedback regarding associated California regulations. The email contained 5 basic questions in combination with a short narrative explaining the purpose of the inquiries. Only one of the contractors contacted replied, with limited applicable information. This contractor expressed the following when asked about their opinion on the California NOA regulations:

> *For the most part, the measures taken are reasonable and consist of greater than normal dust control through the use of more water on grade during earth moving operations and trenching.*

The contractor explained equipment “wash systems” are routinely utilized for decontaminating equipment prior to leaving a NOA site. Another precaution was capping the native material with either a hard surface (concrete, asphalt, ect) or “clean” soil. The thickness of the cap varies depending on the perceived threat of the asbestos, and when soil capping is used it is underlain with a warning fabric to prevent excavations being made into the NOA at a later date.

This contractor did not have certified asbestos workers on staff to perform the removal/handling of hazardous materials such as NOA. They stated their employees are trained to look for hazardous while work is being performed, and if material is encountered which may be hazardous it is either avoided or remediated by a qualified contractor. The following quote explains their route of action if hazardous materials are required to be abated:

> *When we do have a situation develop where hazardous materials are present and they need to be remediated then a proper contractor is brought into service under contract with the property owner keeping us out of the loop.*

To close, the contractor states the NOA regulations in California are not “unbearable” but do add additional costs to affected projects.

Future and Plan of Action

The regulatory authority utilized in the states evaluated included a state-wide program that was implemented across at the local, county level. Typically, multiple disciplines are involved including health, environmental and air pollution control divisions of the regulatory authority.

To date the Alaskan documented experiences in Juneau, Dalton and Ambler all involved transportation projects. Fortunately, once identified they were handled appropriately with additional assessment, training and work practice and product use modifications, each demonstrating once it is known, the NOA material can be safely used. However, while the experiences may not have resulted in any significant human exposures, the late identification resulted in changed conditions and costly non-competitive contract modifications. While NOA encounters in Alaska have been comparatively limited, the need for implementation of a state-wide NOA policy is reinforced by the lengthy, problematic and consequently expensive circumstances that have occurred due to lack of standard operating procedure and/or regulatory guidance. Road and pipeline pad construction and maintenance have and will be the largest future use of gravel resources. For these reasons it is recommended and appropriate for ADOT to take the lead in the further evaluation and development of NOA strategy alternatives and program development. It is anticipated and recommended that ADOT develop internal NOA operations and maintenance (O&M) and design standards for ADOT projects. For maximum effectiveness the department's internal policies and SOP for NOA should reflect a statewide, industry and regulatory consensus. These NOA standards will involve awareness education, resource characterization, acquisition, use as well as required training and development of design requirements, contractor's work practices and O&M practices.

It is readily apparent that the NOA concerns go well beyond the ADOT areas of responsibility involving all aspects of the local people, resource use and community. As demonstrated by other states moving to address NOA issues, a more holistic approach to NOA should involve public health, worker, community and environmental protection advocacy. The existing Alaskan "dust working group" comprised of regulatory and government stakeholders appears as a natural technical committee that could be expanded to include industry and be instrumental for the technical information exchange, development of a statewide NOA strategy(s) consensus and facilitate with the implementation of a successful statewide program.

Clearly the ADOT needs an SOP that that tells ADOT planners, designers and operators how to handle NOA, and this SOP will certainly call for a specific plan for each project. However in order for the SOP to be successful, it must be acceptable to all relevant state and federal agencies, and acceptable to all other stakeholders, such a contractors, materials site owners, and affected communities. Thus the first step is for the ADOT to formulate a NOA Action Plan to solicit comments and advice from all stakeholders, develop drafts of the SOP, circulate drafts to all stakeholders, and present the drafts to all stakeholders.

Working Group

Through the development of the NOA Action Plan (AP) the professional and technical issues can be resolved by the stakeholders working group and applied with state conditions to existing programs developed elsewhere to develop an Alaskan specific program consensus and AP. It is recommended that the working group be comprehensive in make up and include all interested parties or stakeholders. Representatives from government, community and industry should be included. The following is considered a minimum list of known stakeholders that we recommend ADOT consider and include in forming a statewide stakeholder working group.

- BIA
- Alaska Geological Survey
- Denali Commission
- EPA
- ADOT
- ADEC
- DHSS
- Alaska Native Tribal Health Consortium.
- Alaska Tribal Air Call
- Denali Pipeline
- Alyeska Pipeline
- Native Corporations
- Village corporations in areas with NOA
- Community Health Consortium

Coordinating the working group and developing an NOA AP to achieve the goals and targets of these recommendations will require significant commitment and change in operational, management, building and behavioral practices at all levels of agencies and state government. For the AP to be successful, it must have both long term overarching goals and short term, manageable and achievable actions that have short delivery timelines. The statewide working group of stakeholders will be important to providing the forum for technology transfer, alternative strategy consideration, program development and successful implementation of the consensus achieved.

Work of the Working Groups

ADOT's initial working group purpose and scope of work should be fivefold:

- Inform stakeholders on NOA background and needs and solicit participation;
- Define existing NOA control strategies in use;
- Brainstorm actions that best meet all NOA stakeholders unique needs and objectives;
- Develop a Statewide government, industry and community NOA SOP
- Meet and present the SOP to all stakeholders
- Finalize the SOP and develop an example of a site-specific plan for Implementation

How to begin

The California regulations and EPA guidance are a good beginning to any NOA SOP. With some cut and paste and modification for remote projects and Alaskan conditions, those documents could form a draft of the SOP. However caution is needed to not present these or any document to the agencies as a fait accompli. Rather, all stakeholders, especially the relevant agencies, need to help ADOT define the issues and insure the final SOP does not conflict with the charge of any of those agencies

CONCLUSIONS AND RECOMMENDATIONS

This paper reviews NOA background, analytical issues, policies and regulations that have been considered and/or implemented by other authorities involved with NOA and have developed NOA policy options. Based on the analysis of the findings the following conclusions and recommendations have been developed.

- NOA gravels are present throughout the nation and in Alaska which have the potential to impact public health, project development and associated costs.
    - Transportation projects have been adversely impacted by NOA in Juneau, Ambler and on the Dalton Highway.
    - Material site investigations must check for NOA, especially in regions with mineral types likely to contain NOA.
- NOA gravels can be used safety with proper training, understanding and implementation of appropriate control strategies and technologies
    - Technical and regulatory interpretation and definitional issues remain
- Established state NOA programs evaluated have focused their programs on
    - Geologic mapping of "restricted" NOA areas
    - Characterization of NOA free materials based on the analytical procedure's limit of detection of less than 0.25% asbestos content
    - Source characterization sampling from restricted areas
    - If ≥0.25% asbestos, Compliance Plan Submittal and Approval should be required
    - Local authority enforcement to interpret program requirements site specifically and implement additional testing where necessary
    - Development of necessary program exemptions
    - States with NOA programs were developed across public health, environmental and air pollution divisions at the state level and implemented at the local, county level.

It is recommended that ADOT write an action plan to undertake development of a NOA SOP as the lead coordinating entity of a holistic statewide approach that involves all stakeholders and develops a statewide agency, industry and community consensus standard for NOA use. In order to do this, the ADOT should convene a statewide stakeholder's working group to resolve technical issues, work out a consensus on a state wide NOA program.

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