Geochemistry time series from ice/iron cores and snow samples of central Asian glaciers

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ABSTRACT

Atmospheric aerosol composition over central Asia and Siberia were derived from snow/ice core records and calibrated with ground meteorological, airborne, dust, smoke, forest fires, remote sensing and re-analysis data. The ice core stable isotope-geochemistry and NOAA atmospheric pressure distribution data were the basic information for the aerosol dust/biomass, their size and chemistry analysis. The network was set up in modern and pre-industrial time. The NOAA ‘Highjinks’ program modelled air-birth trajectories has allowed to identify association between the ice core geochemistry records (volatile organic major size and dust particles) and the sources of aerosols in western, central and northern Asia.

BACKGROUND: The west and regions of central Asia are the worlds second largest source of atmospheric dust emissions from north-western China, Tajikistan and Afghanistan. The dust aerosol from Aral Sea basin and carbonaceous particles from biomass burning in south Siberian forest found are the primary energy and water cycling forces on the central Asia affecting northern-Pacific and Asia.

OBJECTIVES: To estimate the aerosol/climate interactions through understanding of the processes driving emission sources to cloud and climate distributions, chemical composition, and climatic properties of natural and anthropogenic aerosols.

DATA: (a) descendent geochemistry, atmospheric/satellite transferred forest fire, NOAA AIRMASS, (b) NOAA AIRMASS for Central Asia and Siberia. Meteorological data was obtained from the Idaho University, University of Maine, National Institute of Polar Research in Tokyo, and University of Heidelberg, Germany.

RESULTS: Total annual number of dust storms observed at Central Asian stations (A) and annual and decade weighted average variation, and total particle concentration (B). Oxalate has increased in 1920-1940s when forest in Russia has been burn to expand agricultural lands. The sulfate, nitrate, ammonium, and calcium are dominant in all ice cores. The share of major ion averaged for period of 86 years (A), preindustrialized 1917-1955 period (B), and industrialized 1955-2003 period (C). The sulfate, nitrate, ammonium, and calcium are dominant in all ice cores.

CONCLUSION: Three regions are dust sources to Asia (south-western Siberia): (1) Kazakhstan and Aral Sea basin; (2) Gold Desert; (3) lees from T alternation Desert. Pre-industrial period, P-I (1917-1955): The highest soluble ion loads of organic and formaldehyde. High altitude vegetation emissions are important sources of carbonatic acids for Siberia. Industrialized period, IP (1955-2003): The greatest difference in factor loadings for the industrial compared to the pre-industrial datasets was noted for sulfates. The early 1990's sulfate and nitrate show a decrease because of the population declines and global reduction in atmospheric emissions. The decrease of aerosol loadings for the industrial period (IP) were the most obvious in Asia and northern China. We noted the end of the 90's and 2000's, and agricultural expansion in north-western China.

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Geochemical species’ concentrations and their fine-sampling means with ages.

Antropogenic impact (Biomass Burning): Annual variability of soluble major ions NH4, K, and C2O4, detected in the Belukha ice core. 1917-952.

Oxalate has increased in 1920-1940s when forest in Russia has been burn to expand agricultural lands. However, peaks in NH4, K, and organic acids are coincident with large fires in Western Siberia. Heavy industrialization occurred with the surface, nitrate and ammonium growth from the middle of 50s to 60s. During the early 1990's sulfate and nitrate show a decrease because of the population declines and global reduction in atmospheric emissions. The decrease of aerosol loadings for the industrial period (IP) were the most obvious in Asia and northern China.

A transition to dominating the sulfate, nitrate and ammonium during IP was caused by combined industrial/agricultural factors. Concentration of organic components decreased about one half, preserving the effect of decreased fire intensity. Increase of particles concentration, orind sulfate and ammonium content in ice core is accompanied by decreasing air temperature. The dry deposition may be mainly occurring with cooler temperature. Increase in wind speed cause increases of sulfate, potassium, nitrate, organic acids acetate, calcium and magnesium.

The shifting in factor loadings from P-I to the second for IP (1930-1950) for sea salt aerosol component (i.e. sodium and chloride) and calcium concentrations associated the Artic Sea desertification, which exposed large areas of submarine sediments. An increase in ocean moisture penetrating to western-south Siberia and western Pamir during the warm season could also be linked to the observed changes in sodium and chloride concentrations

The modelled air back-trajectories during seven days for the individual events of heavy precipitation in year 1991 with maximum record in geochemical analysis showed longer distance transport paths, as well as transport over heavily populated regions and over hundreds of oil fires ignited in Kuwait.

Comparatively shorter transport distances during the seven days of air back-trajectories, and transport over Arctic and Polar Regions were revealed for the year of low geochemistry loading.


This research was carried out under several expeditions in Central Asia since 1998. We are also acknowledging our colleagues from the Tomsk State University - Siberian Branch, Ministry of Education, Sports, Science and Technology in Japan; German Research Society (DFG).

Some of the ice-core data for this research has been collected during several expeditions in Central Asia since 1998. We are also acknowledging our colleagues from the Tomsk State University - Siberian Branch, Ministry of Education, Sports, Science and Technology in Japan; German Research Society (DFG).

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