Diurnal Chemical Characteristics of $PM_{2.5}$ over a Source Region of Biomass Burning Emissions in the Indo-Gangetic Plain

RASTOGI N[1], SINGH A[2] AND SINGH D[2]

[1]Geosciences Division, Physical Research Laboratory, Ahmedabad, India
[2]Department of Physics, Punjabi University, Patiala, India
nrastogi@prl.res.in

Wintertime haze/fog has been observed every year over the Indo-Gangetic Plain (IGP); however, the understanding on corresponding particulate composition is meager. The diurnal chemical characteristics of $PM_{2.5}$ were investigated during October-2011 to March-2012 at a site (Patiala, 30.2 ºN, 76.3 ºE; 250 m amsl) located in the source region of biomass burning emissions over IGP. The study period covers characteristic emissions from post harvest paddy-residue burning during October-November (P1), from fossil, wood, and bio-fuel burning during December-February (P2), and from variable regional sources during March (P3).

A striking diurnal variability was observed in $PM_{2.5}$ mass, SO_4^{2-}, NO_3^-, NH_4^+, K^+, OC, EC, and WSOC during P1 with ~30 to 300% higher concentrations of species in nighttime samples. The averaged WSOC/OC ratios for daytime and nighttime samples were ~0.65 and 0.47, respectively in all seasons, suggesting the enhanced daytime secondary organic aerosols formation. The NO_3^- was comparable and OC was higher than SO_4^{2-}, indicating their importance as scattering species over IGP. The averaged $(OC + SO_4^{2-} + NO_3^-)/EC$ ratios for the daytime samples were ~12, 15 and 5.5, and for the nighttime samples were ~18, 14, and 6 during P1, P2 and P3, respectively, indicating the dominance of scattering type species in all the seasons with noticeable diurnal difference during P1, and the contribution of absorbing species (EC) increases from P1 to P3. A strong linear correlation ($r^2 = 0.86$) has been observed between all daytime and nighttime OC and K^+, suggesting that the K^+ can be used as a tracer for biomass burning emissions over IGP with the OC/K^+ characteristic ratio of ~16. Water-soluble species were dominant (≥55%) in $PM_{2.5}$ during winter (P2), and could be the major contributor to fog formation over IGP under favourable meteorological conditions. This study has implications in understanding the effects of biomass burning emissions on regional air quality and climate over IGP, and designing appropriate mitigation strategies.

Isotopic evidence for a crustal Pb source in the giant Broken Hill Pb-Zn-Ag deposit, NSW, Australia

MASSIMO RAVEGGI[1]*, DAVID GILES[2], JOHN FODEN[2], SEBASTIEN MEFFRE[3], MIKE RAETZ[1] AND IAN NICHOLLS[1]

[1]School of Geosciences, Monash University, Melbourne, Australia. (*correspondence:Massimo.Raveggi@monash.edu)
[2]School of Earth and Environmental Sciences, The University of Adelaide, Adelaide, Australia David.Giles@adelaide.edu.au
[2]School of Earth and Environmental Sciences, The University of Adelaide, Adelaide, Australia John.Foden@adelaide.edu.au
[3]CODES, The University of Tasmania, Hobart, Australia. smeffre@utas.edu.au

The Paleo to Meso-Proterozoic Willyama Supergroup, together with the Broken Hill Pb-Zn-Ag deposit, hosts a wide variety of unusual rocks with mineralogical compositions comprising various proportions of quartz ± Fe-oxide ± garnet ± accessories (QFeGA), as well as mafic and felsic ortho-gneisses that intruded at ca. 1685 Ma. Major, trace, REE and U/Pb zircon geochronology data suggests that the QFeGA lithologies are syn-sedimentary, hydrothermal meta-sediments with limited detrital input, similar to hydrothermal sediments forming at present day spreading centers. Neodymium isotope data suggests that the hydrothermal fluids responsible for their deposition were in equilibrium with the Willyama Supergroup (meta)sedimentary sequences.

Lead isotope data from the mafic and felsic ortho-gneisses lie within error on the same 1685 Ma $^{207}Pb/^{206}Pb$ reference isochron with an initial Pb isotope composition of Broken Hill orebody (galena). This is inconsistent with independent geochemical evidence showing that the mafic and felsic ortho-gneisses were derived from end-member mantle and crustal sources respectively. It is inferred that Pb isotope data is the result of a period of regional homogenisation due to pervasive crustal hydrothermal flux at the time of emplacement of the mafic and felsic rocks (ca. 1685 Ma). This is coincident with formation of the QFeGA rocks and the Broken Hill deposit. It is interpreted that the Pb (and other metals) scavenged by this hydrothermal system from the Willyama Supergroup (meta)sedimentary sequences, provided the metals for the Broken Hill orebody

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