Experiments in high temperature annealing of zircon with applications to chemical abrasion

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Chemical abrasion of zircon [1] has proven to be a highly effective method for removing U-Pb discordant domains and improving the accuracy of ages. It relies on the assumption that annealed zircon will dissolve more slowly than altered, discordant domains. This is generally true for zircon with low to moderate degrees of radiation damage, but annealed highly damaged zircon dissolves very quickly in bombs because the 1000°C, 2-3 day annealing procedure does not completely repair radiation damage. It is often difficult to assess optimal leaching times for unknown samples so as to effectively remove alteration from cracks while at the same time not dissolving excessive amounts of unaltered sample. We are conducting experiments with zircon annealed at ca. 1450°C for 1 hour in vacuum. At this temperature zircon slowly breaks down into ZrO_2, evaporating silica [2, 3]. Treated grains become covered by a layer of ZrO_2. Analysis of such zircon produces data that are about 10% discordant, suggesting that while radiogenic Pb evaporates, the bulk of the U remains. Leaching in HF at 200°C for 1 hour removes all visible trace of ZrO_2, leaving grains with a rough, scalloped surface texture. The high solubility of the ZrO_2 is probably due to its fine grain size. Preliminary work indicates that this treatment improves discordance to a level of at least 1-2%. Residual discordance may be due to diffusion of some Pb out of zircon at the high annealing temperature, or the failure to completely remove altered domains from cracks due to the low solubility of the annealed zircon. There is little apparent difference in surface textures of grains leached for 1 hour versus 4 hours and no apparent relationship between discordance and degree of leaching. Experiments with highly radiation-damaged zircon (1.85 Ga, ca. 2000 ppm U) suggest that annealing at 1000°C for 10 days may be more effective at repairing damage than annealing at 1450°C for 1 hour, although both are more effective than annealing at 1000°C for 1 day.

[1] Mattison (2005) *Chemical Geology.* **220**, 47-66.
[2] Ansdell & Kyser (1993) *American Minerologist.***78**, 36-41
[3] Chapman & Roddick (1994) *Earth and Planetary Science Letters* **121**, 601-611.

Dust storm induced modulation of aerosol optical depth: Implications to spatio-temporal variability in atmospheric radiative forcing

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Mineral dust aerosols have a large potential of affecting global climate by influencing the Earth's atmosphere radiation budget through interaction with the incoming shortwave and outgoing longwave radiation. The dust storm events, and major aerosol properties have been studied using ground- and satellite based observations at Mt. Abu (24.5°N, 72.7°E, 1.7 km msl), a high altitude-site in semi-arid region of Western India. The aerosol parameters such as columnar Aerosol Optical Depth (AOD), aerosol number concentration, black carbon mass concentration, aerosol absorption and scattering coefficients and single scattering albedo have been measured during the storm events and normal days. During storm, most of the parameters increased significantly from their mean background levels due to the large abundance of dust particles. During normal days, AOD increased from 0.15 to 0.23 as the day progressed due to upwelling of local pollutants from lower altitudes and during storm, AOD increased significantly and varied from 0.2 to 0.3. AOD attained its background value once the storm subsided. Angstrom exponent varied from 0.05 to 0.3 during the normal days and during the storm it was negative reaching up to -0.5. Aerosol index observed by TOMS, fine mode fraction, etc., derived from MODIS, also showed the storm induced variability. Therefore, dust induced radiative forcing has significantly modulated the atmospheric radiation budget in the western part of India. These results have implications to the uncertainty arising in the atmospheric radiative forcing without systematic parameterization of aerosol parameters.