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Is the geological history of quartz an important factor in silica-related disease?

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Inhalation of fine quartz dust has long been known to be hazardous to occupationally-exposed workers and is the primary cause of fibrosis often leading to silicosis. Quartz may also be carcinogenic to humans. Free radical formation at the surface of freshly fractured quartz particles is usually implicated [1] but the activity decays rapidly with time (usually hours). Animal and *in vitro* experiments inform the setting of recommended exposure limits and a survey of the literature indicates that several different quartz particle standards are in current use. Much care has been taken to ensure that these standards, including MIN-U-SIL 5, DQ12, RH1 and OM, have similar grain size distributions, grain shape and total area, and resemble the physical and compositional characteristics of typical workplace quartz. Nevertheless a recent study indicates marked variability in the biological response to different quartz standards with DQ12 having much greater inflammogenicity and haemolytic activity.

Bulk mineralogy does not seem to be important in determining relative toxicity, as all standards comprise >99% quartz, except for OM which also contains a few percent cristobalite, kaolinite and K-feldspar. X-ray powder diffractometry shows sharp peaks for all standards but considerable differences in peak shape with peak broadening strongly characterising DQ12 compared with the other standards. FWHM on the quartz 101 peak is 0.28 for DQ12 and 0.19 for all the others standards, with similar broadening for neighbouring diffraction peaks. This suggests that DQ12 has a much smaller average crystallite size than the other standards despite similar particles sizes. Electron spin resonance studies in progress on the same standards appear to indicate a dominant paramagnetic centre (the oxygen vacancy E' centre) in DQ12 that is not as dominant in the other standards.

These data suggest that the DQ12 quartz standard has a different bulk structure from the other standards commonly used in quartz toxicology. This might be attributed to differences in mechanical preparation of the standards, although this seems unlikely from the descriptions. Another possibility being investigated is that the quartz sample used for preparing the DQ12 standard was already highly strained, perhaps as a consequence of tectonic processes and geological history. It is important for industry that some form of "toxicity potential" index for quartz is devised, opening the way for safe implementation of variable workplace exposure limits. These results suggest a possible way forward.

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Occurrence and bioaccessibility of metals in household dust from Seattle, USA

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Vacuum cleaner dust (<500 μM) was collected from 50 Seattle houses for the analysis of trace and crustal metals. Participants were asked to complete a questionnaire regarding the history of their house, as well as factors (paint, hobbies, proximity to industries) which might contribute to particular metals loadings. Eight top-soil and eight road-dust samples were also collected as an aid in interpreting the results. Dust and soil from a house located in a remote forested area were used to provide a "background" sample. Samples were analyzed for loss on ignition (LOI) at 525 °C, and the metals results were calculated on both a dry weight and inorganic weight basis.

Samples were digested in sealed Teflon bombs at 100 °C using a mixture of HF + HNO₃ + HCl (15:10:3) and analyzed for Hg using SnCl₂ reduction, amalgamation, and cold vapour atomic fluorescence spectrometry (CVAFS). After Hg analysis, the remaining digest was taken to dryness and then redissolved in concentrated HNO₃, to remove fluoride and chloride, and render all analytes in a pure HNO₃ matrix. As and Se were analyzed using hydride generation interfaced with flame atomic fluorescence spectrometry (HG-AFS), and Ag was analyzed using Zeeman corrected graphite furnace atomic absorption spectrometry (ZGFAAS). All remaining metals (Na, Mg, Al, Ca, Fe, Be, V, Cr, Mn, Cu, Co, Ni, Zn, Mo, Rh, Cd, Sb, Ba, La, Ce, Ir, Tl, Pb, U) were analyzed using inductively coupled plasma mass spectrometry (ICP/MS).

All metals except Rh and Ir were found well above the limits of quantification in virtually all samples. Metals with the greatest average enrichment factors (compared to rural top soil) were Ag (175), Hg (78.2), Pb (77.2), Sb (69.9), Cd (35.8), Cu (25.4), and Zn (22.1). Concentrations of the elevated metals were much higher than, and uncorrelated with adjacent top soil and road dust, suggesting that the source of the elevated metals was within the homes. A sub-set of the most elevated dust samples were assessed for human ingestion bioaccessibility through the use of a sequential *in vitro* stomach acid and intestinal fluid extraction scheme. In general, house dust and top-soil showed similar bioaccessible fractions, with approximately 60-90% of Ag, As, Cd, Pb, and Zn being soluble under stomach conditions. Hg and the crustal elements were generally less than 10% soluble in either stomach or intestinal fluids.