

## Pollution Sources In Ice Cores

### To the Editor:

In studying the excellent paper by Zbigniew Jaworowski, "CO<sub>2</sub>: The Greatest Scientific Scandal of Our Time," [Spring-Summer 2007], I would like more explanation about Figure 2 on p. 18, "Changes in CO<sub>2</sub> Concentrations in Vostok Ice Core Similar to Changes of Extreme Pollution." I have searched the sources noted, but I would like to have particular explanations of pollution interferences.

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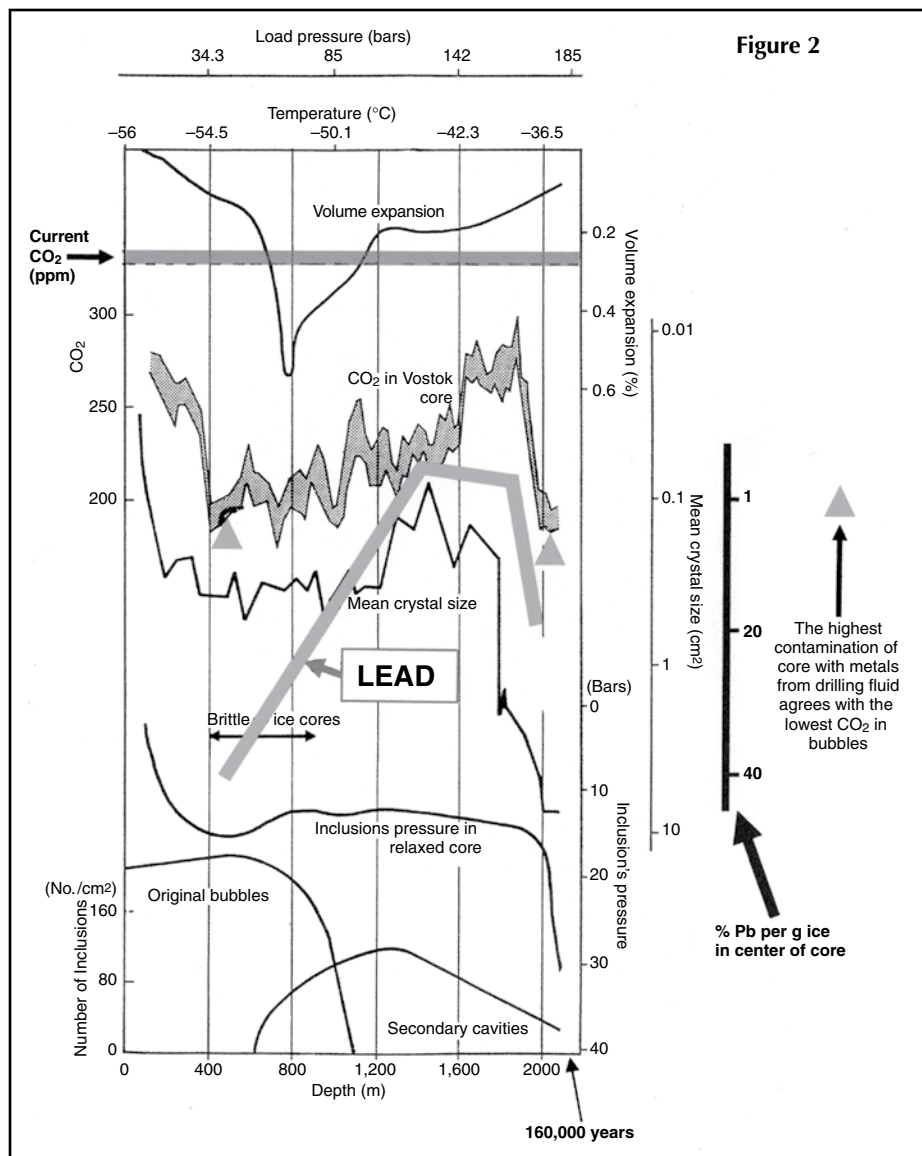
### Zbigniew Jaworowski Replies

Figure 2 is composed from two sources: Figure 11 in Jaworowski, et al. 1992b ["Do Glaciers Tell a True Atmospheric CO<sub>2</sub> Story?" in *The Science of the Total Environment*, Vol. 114, pp. 227-284] in which seven curves represent seven phenomena occurring *in situ* and in the ice cores. Among them, only the CO<sub>2</sub> curve is relevant for discussion of the 2007 paper.

The new curve added to Figure 2 are data on lead concentration from Boutron et al., 1987 ["Preliminary Data on Changes in Lead Concentrations in Antarctic Ice 155,000 to 26,000 Years BP," Vol. 21, No. 5, pp. 1197-1202], covering the same depth (and ice age) as the CO<sub>2</sub> curve.

Figure 2 shows that the highest concentration of lead in the ice core appeared at the same part of the core as the lowest concentrations of CO<sub>2</sub>. This reflects the effect of horizontal cracks formed in the ice at the moment of drilling the core. Through these cracks, the drilling fluid, highly contaminated with lead and other heavy metals, penetrated to the very center of the core, and CO<sub>2</sub> escaped to the fluid from the cracked ice.

The cracking is due to the sheeting phenomenon, which is caused by a difference of pressure between the rock (or



ice), and the bottom of borehole filled with the drilling fluid. The corrosive drilling fluid is filling the borehole not to the surface of the ice, but to about a level of 200 meters below the surface, at which the porous firn is already changed into solid ice.

This causes a pressure difference at the bottom level of the borehole in ice of about 15 bars. Sheeting starts at a pressure difference of 8 bars.

The lead curve is more or less parallel to some other effects, such as formation in the ice core of secondary cavities from the expanding clathrates, due to pressure relaxation, decreasing pressure in the gas inclusions, crystal size, and perhaps also

core volume expansion. This is what Figure 2 says.

### Correction

In "CO<sub>2</sub>: The Greatest Scientific Scandal of Our Time" (Spring/Summer 2007, pp. 14-28), the statement on p. 22 (left column) that "the Sun has been the dominant cause of the strong warming during the past three decades" is that of the author, Zbigniew Jaworowski, and is not from the quoted reference Solanki et al. 2004. The reference to Solanki et al. 2004 should have appeared just after Figure 7, for it refers only to Figure 7. *21st Century* apologizes for this editorial error.