PINK ANGEL: ARGON AND XENON DIFFUSION, I-Xe CHRONOLOGY AND THE $^{36}$Cl PROBLEM. G. Turner¹, S.A. Crowther¹, R. Burgess¹, G.J. Wasserburg² S.P. Kelley³ and J.D. Gilmour¹ ¹SEAES, University of Manchester, Manchester M13 9P1, UK. grenville.turner@manchester.ac.uk. ²California Institute of Technology, USA. ³Open University, UK.

Introduction: The reported presence in Allende Pink Angel sodalite of excess $^{36}$S [1] attributed to $^{36}$Cl decay is at odds with the apparent absence of a corresponding excess of $^{36}$Ar, which is the major decay product of $^{36}$Cl. In an attempt to throw light on the problem we have reviewed new and existing data on the diffusion of Ar and Xe in sodalite, carried out new high resolution I-Xe analyses of Pink Angel, and devised a new methodology for searching for small excesses of $^{36}$Ar from $^{36}$Cl decay.

Diffusion of Ar and Xe in sodalite: Our experiments on neutron irradiated terrestrial sodalite indicate high retentivity of Cl-derived $^{38}$Ar. During stepped heating, maximum release occurred around 1100°C and release was essentially complete by 1250°C. An activation energy of 280 kJ/mol/K was calculated. Published data [2] from an I-Xe analysis of Pink Angel sodalite indicates peak release of I-derived $^{129}$Xe around 1200°C with significant release up to 1400°C. An activation energy for Xe diffusion of 460 kJ/mol/K is inferred. To calculate the implications for possible Ar and Xe loss over time scales appropriate to the early solar system we scale time, $t$, and absolute temperature, $T$, using the expression: $1/T_2 = 1/T_1 + R/E \ln(t_2/t_1)$ where subscripts 1 and 2 refer to the laboratory and early solar system times and temperatures, respectively. To release essentially all of the Cl-correlated Ar and I-correlated Xe on a timescale of 1 Myr would require sustained temperatures of around 460°C and 740°C respectively.

I-Xe analyses: We have carried out laser stepped heating I-Xe analyses of Pink Angel sodalite using the RELAX resonance ionization spectrometer. Two samples, weighing 40ug and 80ug have been analysed with a total of 90 individual extractions. A well defined plateau indicates $^{129}$I/$^{127}$I = (0.93 ± 0.02) x 10⁻⁴, corresponding to an I-Xe age 3.2 ± 0.3 Ma after our monitor, the Shallowater achondrite. Lower $^{129}$I/$^{127}$I ratios in the early release could imply a 12% later loss of $^{129}$Xe concomitant with significant loss of $^{36}$Ar.

$^{36}$Cl Searches based on $^{36}$Ar: We suggest a new method to search for $^{36}$Ar excesses which makes use of a plot of $^{36}$Ar/$^{38}$Ar vs. Ca/$^{38}$Ar. End members are trapped, cosmogeneic and cosmogeneic secondary neutron-induced argon. In suitable circumstances excess $^{36}$Ar would plot above this mixing triangle. Determination of Ca using a reactor irradiation requires low fluences and Cd-shielding to minimise $^{38}$Ar production from Cl.

In conclusion we note that absence of excess $^{36}$Ar in spite of the high retentivity of sodalite leaves open the possibility that either the reported $^{36}$S excess is an artifact or else it is inherited from an unidentified pre-existing Cl-rich phase which has lost $^{36}$Ar and the apparent correlation with Cl/S represents a two component mixing line and not an isochron.