NUCLEAR TRACKS AND NOBLE GASES IN TEN UNEQUILIBRATED H-CHONDRITES FROM THE SAHARA; J. Romstedt[1], L. Schultz[2] and K. Metzler[3], [1]Institut für Planetologie, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany. [2]Max-Planck-Institut für Chemie, D-55128 Mainz, Germany. [3]Institut für Mineralogie, Museum für Naturkunde, Humboldt Universität zu Berlin, Invalidenstr. 43, D-10115 Berlin, Germany.

Abstract: We present nuclear track densities as well as concentrations and isotopic composition of He and Ne of ten unequilibrated H-chondrites. All meteorites are recent finds from the Algerian Sahara and have low shock stages (S1-S2). According to the presence of trapped solar gases and solar-cosmic-rays-irradiated olivines two of the investigated chondrites are regolith breccias, two other meteorites show loss of cosmogenic ^{3}He accompanied by shortening of nuclear tracks. For most of the meteorites the shielding depth and preatmospheric radii are estimated.

Introduction: Modern falls and Antarctic meteorites present two meteorite groups that have different terrestrial ages. It was proposed that both may represent individual populations with different signatures [see 1]. Meteorites from hot deserts, however, represent stones with terrestrial ages between these two groups [see 2]. We have thus studied nuclear tracks and noble gases of ten recently found H3-chondrites from the Acfer region (Algeria) to obtain information on their thermal and irradiation history.

Nuclear tracks and cosmogenic nobles gases originate from the interaction of cosmic rays with meteoritic matter. Both are accumulated in the meteoroid during the flight from the parent body to Earth. Although the original shape of the body is destroyed due to ablation, nuclear tracks and noble gases contain information about the initial (preatmospheric) radius of the meteoroid. From concentrations of cosmogenic isotopes the exposure age is obtained. However, the shielding of the sample (preatmospheric radius and depth of the investigated sample within the meteoroid) must be known. This information is obtained from track studies.

Sampling and experimental procedures: All samples were taken from a single location within each meteorite. The noble gases were measured by conventional mass spectrometry. The track analysis was performed on a thin section as well as on selected olivine grains. Up to 200 clear olivines were collected, mounted in epoxy and polished. The thin section and the selected olivines were etched in WN-solution [3] for 0.5h and 4h, respectively.

The investigation of entire etched thin sections makes it possible to detect grains irradiated by solar energetic particles. Thin sections were scanned by an optical microscope with 320 fold magnification.

The track density induced by galactic cosmic rays is determined on selected olivines by optical microscopy with 1600 fold magnification. Track production rates as a function of depth for spherical meteorites with different radii were calculated according to [4]. Due to different track recording efficiencies in pyroxene and olivine [5] and revised production rates for cosmogenic nuclides [6], the values given in [4] are modified. Taking into account the recovered masses of the chondrites the shielding depth and preatmospheric radii (assuming spherical shape and concentric ablation) are estimated.

Results and conclusions; Regolith breccias: Acfer 153 and Acfer 192 contain components irradiated by solar energetic particles on the parent bodies surface. Both have significant amounts of solar noble gases (Tab.1). Thus, both meteorites are regolith breccias.

Track annealing and loss of cosmogenic ^{3}He: Two of the investigated meteorites (Acfer 22 and Acfer 129) show a significant ^{3}He loss. This becomes visible in Fig. 1 where these two meteorites have $^{3}He/^{21}Ne$ ratios lower as expected from the shown correlation [7]. This He-loss is caused by a recent heating event in the orbit as meteoroid and is indicative for small perihelia. This heating event is also visible in the thermal annealing of nuclear tracks. Olivines of Acfer 22 show a homogenious annealing of all tracks. The few visible tracks have a length of only 1-2 µm. Obviouly this meteorite is heated in an orbit close to the sun.

For Acfer 129, a different picture is observed. Tracks are less shortened and track densities are distributed over several orders of magnitude. Samples taken from larger distances (1 cm) to the fusion crust show a lower degree of annealing indicating a steep thermal gradient. The distribution of track densities may reflect a preferential annealing in certain crystallographic directions and shows that the warming did last for a short time only. These observations suggest that observed temperature effects of Acfer 129 were caused by the frictional heat during the meteoroids entry in the Earth's atmosphere or heating on earth.

Ablation and preatmospheric size: With exception of Acfer 22 and Acfer 129 which experienced a heating event prior to their fall the shielding depth of the samples and the preatmospheric size of the meteorites is estimated, whereby the regolith breccias Acfer 153 and Acfer 192 have the smallest radii with 7 cm and 5 cm, respectively. For six meteorites (Acfer 23, 28, 171, 178, 210 and 211) the values of the shielding sensitive $^{22}Ne/^{21}Ne$ ratio are

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plottet versus the track production rates (Fig. 2). The observed trend [see 8] shows again that tracks and cosmogenic $^{22}Ne/^{21}Ne$ ratios can be used as parameters for shielding corrections. It also indicates a single stage exposure in space for every meteorite shown in Fig.2.
Since a pairing of these meteorites can be ruled out by the noble gas, track or petrographic data, all samples belong to individual meteoroids of a similar radius. The investigated Saharan meteorites are similar according to their irradiation and thermal history to modern falls or Antarctic meteorites .

Table 1: List of investigated Meteorites, noble gas concentration [10^{-8} cm^3 STP/g], exposure age, track production rate and depth within the meteoroid. For regolith breccias a value of 1.11 for $(^{22}Ne/^{21}Ne)_c$ is assumed.
ΔX: depth R_0: preatmospheric radius

Meteorite	^3He	^4He	^{20}Ne	^{21}Ne	^{22}Ne	$(^{22}Ne/^{21}Ne)_c$	exposure age (^{21}Ne) [Ma]	TPM x10^5 [tracks/ cm^2 Ma]	ΔX [cm]	R_0 [cm]
Acfer 22	16.10	537	7.96	7.22	8.26	1,127	25.1	--	--	--
Acfer 23	14.50	1188	5.30	3.84	4.40	1,098	11.8	0.27	12	14
Acfer 28	45.50	1660	8.88	9.19	10.42	1,131	32.5	1.17	6.5	12
Acfer 129	25.00	1090	6.59	5.84	6.90	1,165	23.6	--	--	--
Acfer 153	44.10	80100	121.00	4.86	16.60	(1,11)	15.7	2.25	5	7
Acfer 171	48.70	1540	9.92	10.30	11.60	1,123	35.3	0.72	8	11
Acfer 178	16.60	1280	5.73	4.11	4.74	1,105	13.0	0.40	10	13
Acfer 192	12.10	13600	35.20	1.44	4.59	(1,11)	4.7	6.44	2.5	5
Acfer 210	13.80	1110	4.09	3.46	3.89	1,097	10.5	0.48	10	14
Acfer 211	41.60	1390	7.40	7.10	8.22	1,149	27.0	1.60	6	10

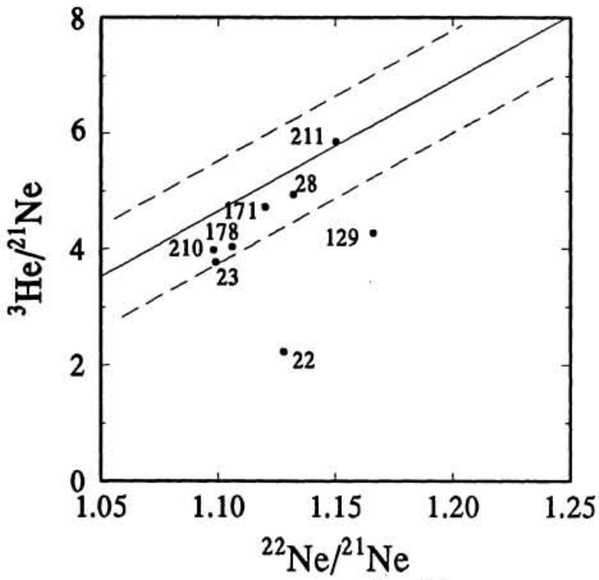

Fig. 1 Correlation of cosmogenic $^3He/^{21}Ne$ and $^{22}Ne/^{21}Ne$ ratio in the "Bern-Plot". Solid line according to [9].

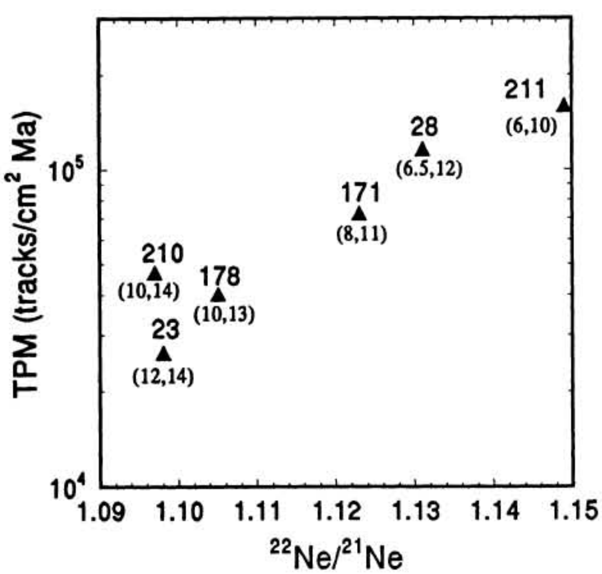

Fig. 2 TPM vs. cosmogenic $^{22}Ne/^{21}Ne$ ratio Numbers: Acfer meteorites; Numbers in parenthesis: shielding depth and preatmospheric size, respectively.

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