GRADISTIC VS. CLADISTIC VIEWS IN THE CLASSIFICATION OF CHONDRITES: THE (L,H) DICHOTOMY AND THE MISSING L/LL PRECURSORS. (NIPR STATISTICS VI.) ***B. Lukács*[1]*, Agnes Holba*[1]*, & Sz. Bérczi*[2]**, [1] Central Research Institute for Physics RMKI, H-1525 Budapest, 114. P.O.Box. 49., Budapest, Hungary, [2] Eötvös University, Dept. G. Technology, H-1117 Budapest, Pázmány Péter s. 1/a, Hungary; (lukacs@rmki.kfki.hu, bercziszani@ludens.elte.hu)

INTRODUCTION

While carbonaceous chondrites as a more or less recognizable group goes back at least to Berzelius and Wöhler, the complete classification of chondrites had to wait until Urey, Craig, and Wiik and others immediately afterwards. Today it seems as if the task were almost done; however important facts are still without satisfactory, or even any, explanation. We would like to term the problem as the (seeming?) lack of precursors of the L and LL chondrites. We choose to take here an evolutionary viewpoint.

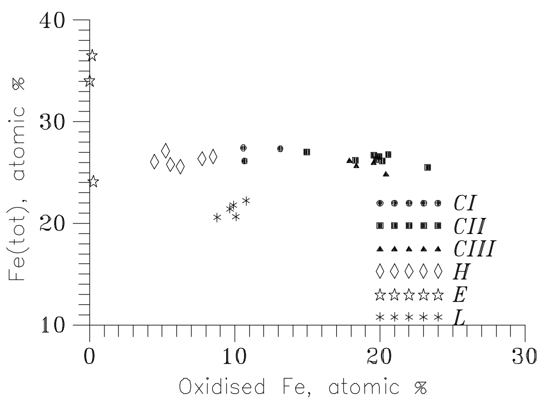

Fig. 1: 29 chondrites of Wiik, in 1956

The chondritic structure is of course a proof that they were not melted after formation, so except for volatiles as C and H_2O they must still keep the original composition. Volatiles, on the other hand, suggest that carbonaceous chondrites would be nearer to the "primordial" status.

WIIK'S SET (30), NIPR SET (500)

Now let us go back to Wiik (1956) [1]. The Urey & Craig (1953) [2] result was that chondrites seemed to form only 2 disjoint groups, H(igh) and L(ow) for total Fe content. Wiik selected 30 very careful measurements and to the obvious question: what would be the connection with the "primitive" C's, he got and the answer that all measured C's belonged to the H group (Fig. 1). So C's may be the "ancestors" of H's (and E's?), but not of L's.

Now, this was not a necessary conclusion in one direction. A Linnaean viewpoint, that all types were independent, was also possible. However, in an evolutionary scheme (Fe/Si content is initial condition) H's can have precursors (Bérczi & Lukács, 1998, [3]), but precursors of L's were not seen. After more than 4 decades the situation is still the same (Fig. 2).

While, unfortunately, the big and homogeneous NIPR Antarctic Meteorite Catalog (more than 500 chemical compositional data, Yanai, Kojima & Haramura, [4]) does not contain carbon data, from H_2O we can more or less guess primitive and derived subgroups. It seems as if smaller petrologic types belonged to more primitive meteorites (although see Zolensky & al. [5], or [6]). Now see Fig. 3, for petrologic type (PT)≤3 meteorites of the NIPR Catalog. It seems as if L's and LL's were born as Pallas Athene, in mature state, in full armor.

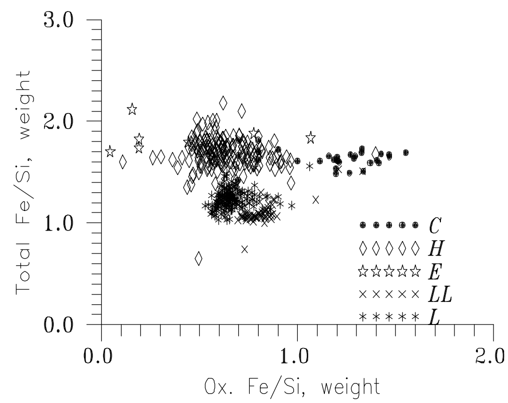

Fig. 2: Fe/Si data in the NIPR Catalog, 1995

PRECURSORS OF ORDINARY CHONDRITES ARE SHOWN BY THE AQUEOUS ALTERATION?

Some *ordinary* chondrites underwent previous aqueous alterations *as many C's* (Krot & al., [7]). This is not a fundamental problem as far as we do not note Semarkona LL3.0 [7], which seems to have reached *after aqueous alteration* the very initial unequilibrated state accepted for

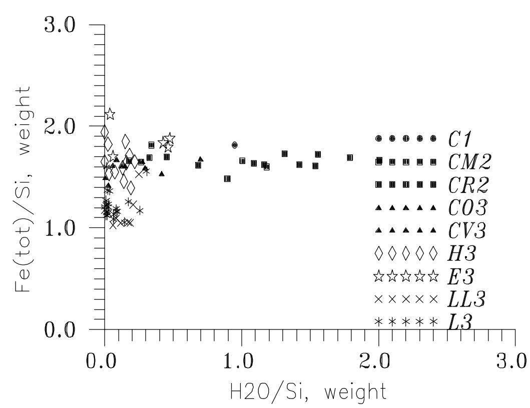

Fig. 3: NIPR chondrites, 1995, up to PT 3

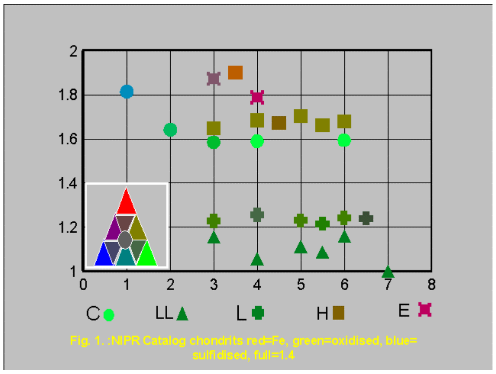

Fig. 1. :NIPR Catalog chondrits red=Fe, green=oxidised, blue= sulfidised, full=1.4

Fig. 4.

an LL. But then earlier stages must have existed: how

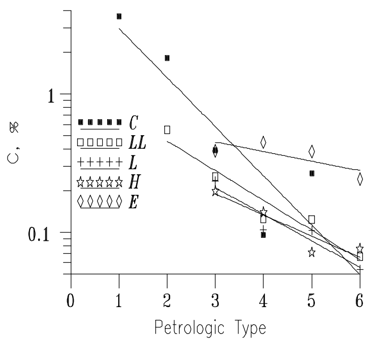

Fig. 2: C averages from Hayes, Otting & Zahringer and Hutchison. Lines: exponential fit.

could they be completely erased now? LL3's cannot go back to C2's, because of different initial conditions for e.g. Fe.

Fig. 6.

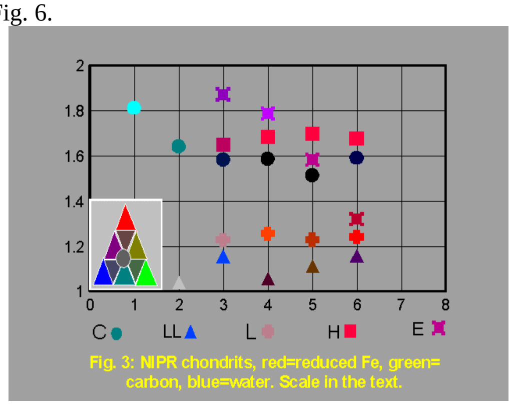

Fig. 3: NIPR chondrits, red=reduced Fe, green= carbon, blue=water. Scale in the text.

WAYS TO SOLUTIONS

We list two logical possibilities; maybe a combination of them will lead later to the proper answer. First, we may accept petrologic type 3 as the true initial stage, and derive PT 2 and 1 thence by aqueous alterations. This would be Zolensky & al.'s way [5] except that they started only from PT 2; see another paper of Bérczi & Lukács [6]. Also, we may look for LL2's in another way. Note that Hutchison & al. (1987) [8] many years ago claimed Semarkona and Bishunpur to be LL2. They are, indeed, not unsimilar to virtual "carbonaceous" LL2's: their carbon content is higher, and water is at least as abundant or higher than in LL3's (Jarosewich, 1990, [9]).

GRADISTIC VS: CLADISTIC VIEW

We think that the problem is at least partly a consequence of mixing the gradistic and cladistic viewpoints. Comparing grads in an evolutionary process C is the name of the "undeveloped", "primitive" stage, with many volatile, while H (E) and L (LL) are the "higher evolutionary stages". On the other hand, in a cladistic view C may have gone "as far" as the others from the startpoint, and then C3 (the "olivine-pigeonite chondrites, Brooks & Shaw, [10]) is comparable to H3 or LL3, or C6 (equilibrated) to H6; and the different initial conditions (for at least Fe and Mg (Bérczi & Lukács, 1997, [10]) support this view, because the evolution with different initial conditions cannot merge. But the historic past still lingers, because the "main groups" have still preserved the notations of the gradistic past.

SUMMARY OF THE Fe°-C-H_2O RACE

Now let us put away the problem of precursors and take a bird's eye view on the main chemical processes within individual chondrite groups. Figure 4 contains all chondrites of the NIPR Catalog with definite petrologic type. The height of the curve shows total Fe/Si, while the color is a three-color mixture, red for metallic Fe, green for oxidized one and blue for sulfidized one, pure color is X/Si=1.4. One sees 2 facts. First C1 Y-82162 (the only one in the Catalog) cannot be in genetic relation with the average latter C's and H's, but still may be with E's. Second, the so called H3-4's cannot belong to the H sequence, but cannot belong either to the E sequence, being the sulfide too few in them.

Now we would like to get a similar Figure for the oxidation/reduction race. But, unfortunately, the NIPR Catalog does not give C. So we must turn to the smaller statistics of Hayes [12] and of Otting & Zähringer [13]. In addition now we accept the suggestion of Hutchison & al., and take Semarkona and Bishunpur [9] as LL2. Then we get average C contents (Fig. 5), and we append the NIPR Catalog for LL2, C5, E5 and E6 from Refs. [8] and [9]. Now on Fig. 6. the valences are compared in colors (Fe=2, H=1 and C=4), reduced Fe is red, C is green and water is blue, and the color scales are independently normalized for each group so that the maximal value within the group is 100.

On the High line C is in the same relation to H as on the Low line LL to L: on both the first is water-dominated while in the second there is Fe° surplus. E's needs further discussions.

REFERENCES: [1] Wiik H.B., GCA **9**, 279, (1956); [2] Urey H.C. & Craig H., GCA **4**, 36 (1953); [3] Bérczi Sz. & Lukács B., Antarctic Meteorites **XXIII**, 4-6 (1998); [4] Yanai K. et al., *Catalog of the Antarctic Meteorites*, NIPR, Tokyo, (1995); [5] Zolensky M.E. & al., GCA **61**, 5099, (1997); [6] Bérczi Sz. & Lukács B., this Volume (1999); [7] Krot A.N. & al., GCA **61**, 219, (1997); [8] Hutchison R. & al, GCA **51**, 1875, (1987); [9] Jarosewich E., Meteoritics **25**, 323-337 (1990); [10] Brooks J. & Shaw G., *Origin and Development of Living Systems, Academic Press*, London, (1973); [11] Bérczi Sz. & Lukács B., Antarctic Meteorites **XXII**, 6-8 (1997); [12] Hayes, J.M. GCA, **31**, 1395, (1967); [13] Otting W. & Zähringer J. GCA, **31**, 1949, (1967);