GLANERBRUG - AN LL4-6 FRAGMENTAL BRECCIA WITH HUGE L CHONDRITIC CLASTS.
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Introduction: The Glanerbrug ordinary chondrite fell April 7, 1990 through the roof of a house in the Netherlands [1,2]. The inhomogeneous character of the rock was recognized immediately [1] and Glanerbrug was officially classified as an LL breccia [3]. In later publications Glanerbrug was described as an L/LL5 chondrite (e.g., [4]). Based on the somewhat unclear and inconsistent classification we have studied Glanerbrug in detail again.

Results: Welten et al. [2] found that within the main fragment of Glanerbrug a dark-grey breccia occasionally containing blackish inclusions is separated from a light-grey lithology by a sharp boundary. We have studied several polished thin sections of Glanerbrug (PL04055 and PL04057) by optical and electron microscopy and electron microprobe. The two different units described by [2] are probably those shown in Figures 1 and 2.

Unit One. This brecciated lithology (Fig. 1) is well characterized by the light-dark structure. Various types of clasts (types 4-6) are embedded in a clastic, porous matrix (Fig. 3). The fine-grained, dark clastic matrix can be recognized as the host material as already suggested by [2]. This dark portion is less homogenous than the light lithologies. Welten et al. [2] found that olivines within the dark portions of two thin sections have quite variable compositions (27.0 ± 1.5 and 30.0 ± 1.0 mol% Fa, respectively). Analyses of olivines and pyroxenes within the clastic matrix of our sample revealed 29.5 ± 1.7 mol% Fa and 23.5 ± 4.1 mol% Fs, respectively. Thus, these results would indicate an LL chondritic origin. Based on the standard deviation the matrix can be considered as slightly unequilibrated; however, this may be due to a small abundance of tiny L-group clasts within the fine-grained matrix. No olivines or pyroxenes with really low Fa- or Fs-contents were detected. As shown in Fig. 1 many different types of fragments were embedded within the dark clastic matrix. Several clasts have been analyzed in detail. The fragments F01, F08, F10, F12, and F13 are well recrystallized and clearly of petrologic type 6; the average Fa-content of each clast is close to 31 mol% [5]. Thus, these clasts are clearly of LL-chondritic composition. Olivines of other fragments have lower Fa-contents (compare Figs. 1 and 4; average values in mol% Fa): F07: 27.8, F02: 27.3, F03: 28.0, F09: 29.3, F05: 27.3, F04: 26.4, F06: 25.6 [5]. Although a gradation between LL-and L-chondritic materials can be recognized, the last two fragments can be classified as L-chondritic clasts.

Unit Two. This lithology shown in Fig. 2 is light-colored and contains chondrules. Petrologically, it can be characterized as a type 4/5 lithology. Olivines and pyroxenes within this lithology are well equilibrated (average: 25.6 mol% Fa and 21.8 mol% Fs, respectively [5]) and clearly within the range of L-chondritic material (high Fa-Fs end of the L-field). This lithology can be regarded as a huge L-chondrite fragment within the LL chondritic bulk rock.

General observations: The matrix of Glanerbrug is not well lithified. The lithic constituents are very angular and a high degree of porosity occurs between individual clasts. Thus, Glanerbrug can be classified as a Class A breccia concerning the degree of lithification [6]. Based on the lack of solar wind implanted noble gases Glanerbrug is a fragmental breccia [7]. Using the shock stage classification scheme of [8] the bulk rock is only very weakly shocked (S2; [4,5]). Some of the type 6 fragments show shock veins.

Discussion: Glanerbrug is a very complex fragmental breccia. We suggest that the host rock is of LL chondritic origin as already stated by [2]. The parent body has incorporated xenolithic fragments, which represent material of the high Fa-Fs end of L chondrites/low Fa-Fs end of LL chondrites (Fa: 25.5-28 mol%). Mixing and lithification occurred close to, but certainly not at the upper surface of the parent body as indicated by the lack of solar wind implanted noble gases [7]. Based on our results we classify Glanerbrug as an LL4-6 fragmental breccia with huge L-chondritic clasts.

References: [1] Lindner L. et al. (1990) *Meteoritics, 25,* 379-380. [2] Welten K. C. (1992) *Meteoritics,27.,* 307. [3] Wlotzka F. (1991) Meteoritical Bull. *Meteoritics, 26,* 68-69. [4] Rubin A. E., (1994) *Meteoritics, 29, 93-98*. [5] Niemeier M. (2005) Diploma thesis, Institut für Planetologie, Universität Münster, 1-193. [6] Bischoff A. et al. (1983) *Earth Planet. Sci. Lett., 66,* 1-10,. [7] Loeken T. et al. (1992) *Meteoritics, 27,* 251. [8] Stöffler D. et al. (1991) *Geochim. Cosmochim. Acta, 55,* 3845-3867.

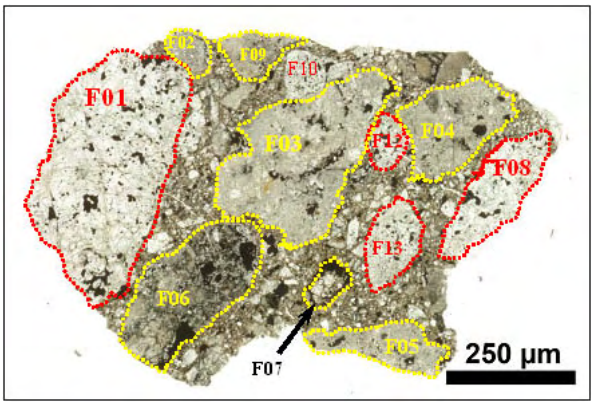

Fig. 1: The dark lithology (Unit One) of the Glanerbrug ordinary chondrite fragmental breccia. Various type of clasts are embedded within a fine-grained, dark clastic matrix.

Fig. 2: The light lithology (Unit Two) of the Glanerbrug fragmental breccia. Various types of chondrules are clearly visible.

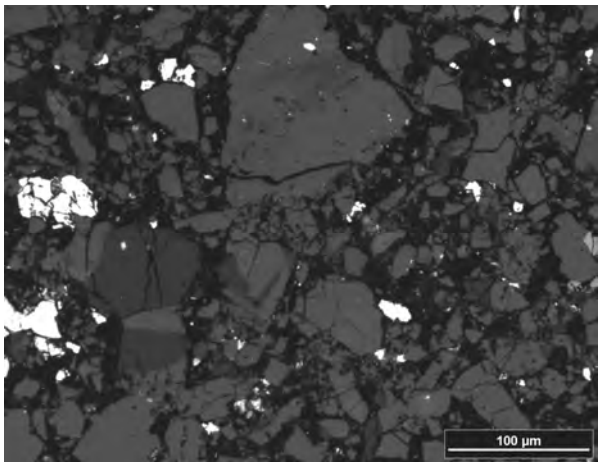

Fig. 3: The fine-grained, dark matrix (Type A) of Glanerbrug. Note the clastic appearance of the constituents and the high portion of porosity (black areas). Photograph taken in reflected light.

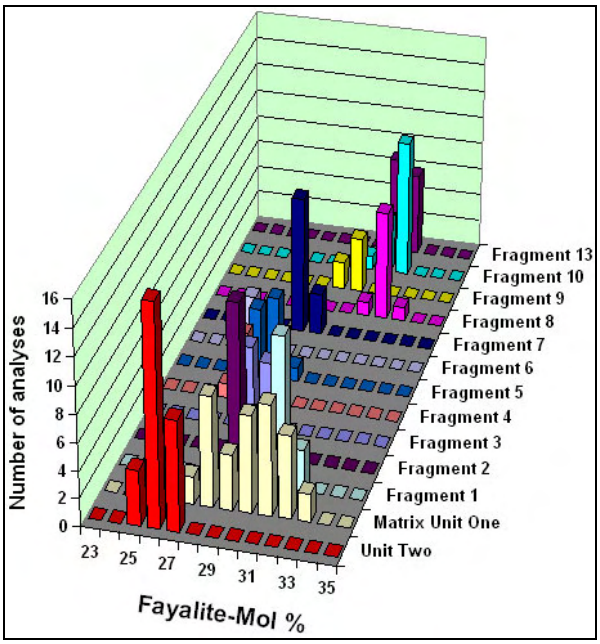

Fig. 4: Composition of olivines in various clasts (compare Fig. 1) and within the fine grained dark matrix of Glanerbrug (data in mol%).