DISTRIBUTION AND SOURCE OF WATER IN THE CONTINUOUS BUNTE BRECCIA DEPOSITS OF RIES CRATER; GERMANY. A. Pietrek[1], T. Kenkmann[1] and D. Jung[2] ,[1]Institute of Earth and Environmental Sciences - Geology, Albert-Ludwigs-University, Germany (alexa.pietrek@geologie.uni-freiburg.de), [2]Bavarian Agency of Geology, Hof, Germany

Introduction: The Ries crater is a 26 km, Miocene impact structure which formed in a ~750 m thick succession of layered sediments (claystone, siltstones, sandstones, marls and limestones) overlying a Variscian basement (mainly gneisses, amphibolites and granites [1]). The continuous deposits are a lithic breccia formed mainly from the sedimentary cover of the target (Bunte Breccia, BB), which is overlain locally by Suevite (S). A recent 3D compilation of the morphology and thickness distribution of the continuous Ries ejecta deposits [2] revealed a concentric ejecta depression and a massive accumulation of ejecta similar to the morphology of Martian double layer (DLE) craters. The Ries crater formed both in the presence of an atmosphere and target volatiles. Vertical vents emanating directly at the S-BB contact document that substantial amounts of water were present in the BB and were vaporized after coverage with hot S [3, 4]. For this study, the two fully cored drill cores Itzing (7 km ESE of crater rim, 1.56 Rc) and Otting (3.5 km E of crater rim, 1.28 Rc) from 1976 (previously described by [5]) were reevaluated. The main objectives were (1) to identify textures and deformation styles indicative for the influence of water, (2) to link that water to its pre-impact source reservoir, and (3) to characterize the influence of water on the emplacement process.

Observations: *Drill core description:* Itzing drill core has a length of 64 m with ~52 m of BB. The BB is a succession of interlayered monomict or dimict crater-derived breccias deposited over a polymict basal layer enriched in local material in contact with the authochthonous Malmian limestone. Unit I is a 16.55 m thick crystalline breccia mixed with red and white Keuper sandstone and claystone. Unit II-a (16.55-22m) is a Lias black shale breccia with inclusions of red Keuper clay fragments, interlayered with a monomict marl breccia with mortar texture. The Lias black shale shows mainly brittle fracturing with subordinate local weak plastic deformation. Unit II-b (22-37.8m) is a several decameter thick mixture of different white and red Keuper sands and clays, interrupted by solid blocks of a pale green-red mottled Keuper clay. Unit III (37.8-52.1m) is a repetition of monomict or dimict limestone breccias and a polymict breccia (PBb) with a clayey to silty, brownish matrix and between estimated 20 and 40% clasts. Over 80% of clast are limestone or Tertiary clays, with an increase of Tertiary clays with depth, both in matrix and clast content. Clasts are angular except for finely laminated Tertiary clays, which are intensely plastically deformed. The boundary to the autochthonous Malm (Unit IV) is
not distinctive and was estimated to lie at around 52.1 m, judged by the degree of fragmentation and displacement of the limestone.
Otting drill core has a total length of 69.5 m, with ~47 m of BB. It is topped by 9 m S (Unit I, [4]). Unit II-a (0.9-11.3m) is a succession of a polymict breccia, a Keuper sandstone breccia and silty to fine sandy marls deformed by ductile flow. Unit II-b (11.3-26.0m) is a polymict breccia (similar to PB1) with a brownish-gray, clayey matrix and 20-25% angular clasts. Unit II-c (26-28.2m) is a repetition of PB1 and a second polymict breccia PB2. The latter (Unit II-d, 28.2-38.7m) has a light whitish to reddish, silty to sandy matrix with a similar modal clast content than PB1, with the additional rare occurrence of crystalline clasts. Unit III (38.7-58.4m) is a polymict breccia similar in texture and modal composition to PBb of Itzing drill core. The contact to the autochthonous limestone (Unit IV) forms a distinct surface with striations [5].

Indicators for water: Tertiary clays generally are intensely plastically deformed. They are often found wrapped or welded around competent clasts of different lithologies. Tertiary clays are not present in the upper breccia units of both cores, but are volumetrically dominant in the deepest BB unit (PBb), directly above the contact to the autochthonous limestone. Keuper sandstones form several meter thick deposits deformed by plastic flow in Itzing drill core. A thin marly phase in Otting drill core shows the same plastic deformation behavior and furthermore has formed several injections into a polymict breccia body.

Discussion: The loamy properties of Tertiary clays suggest they were unconsolidated and saturated with water during emplacement. The exclusive occurrence in the basal breccia unit of both cores suggests they are secondary, local material, eroded by the ground-hugging ejecta flow of the BB, as described by [6, 7], and possibly acted as lubricant at the base of the flow. The ductile flow and intense plastic deformation of the original sedimentary structures of several meter of Keuper sandstones require the complete destruction of the grain matrix to allow the mobility of material observed in the samples. Similar textures are described by [6] and are a common texture of Keuper sands in the BB. Mechanical fragmentation and abrasion of rock material between clasts, the mechanism proposed for the formation of mortar texture [7] is believed to be not sufficient to allow this cataclastic flow down to the grain-scale. We propose decompression vaporization of pore water as additional mechanism [8] enhancing fragmentation and formation of the flow patters by granular flow. The injection features near the S-BB contact in Otting drill core are similar to sedimentary injection features which can form in compressed, water saturated sediments when they are buried. This implies that the marly phase was fluidized and over pressured, probably due to the heat of the hot S emplaced few cm above.

In conclusion, water in the BB was derived from surface water stored in unconsolidated Tertiary clays. Those were reworked from the top of the target during emplacement and possibly lubricated the basal breccia units in both cores. Water was introduced into the crater-derived upper units of the BB through pore water of deep seated lithologies (Upper Jurassic marls, Keuper sandstones.)

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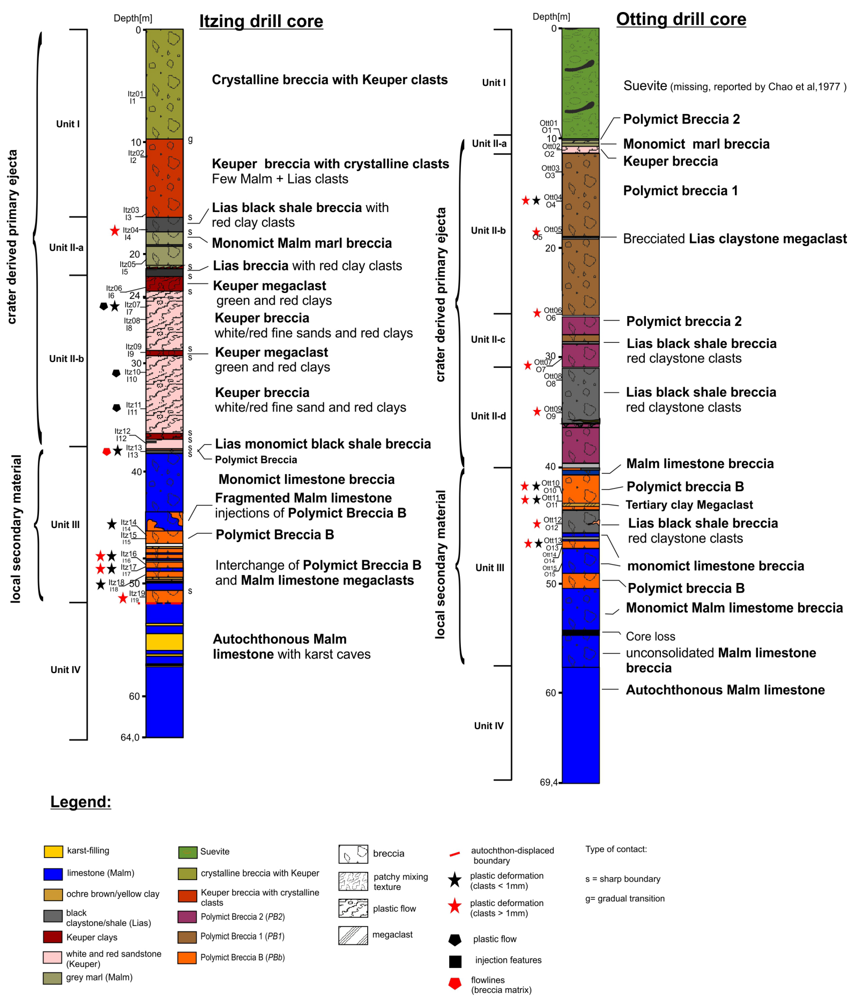

Fig. 1: Schematic profiles of Itzing (left) and Otting drill cores (right). Both drill cores are topped by impactites derived mainly from the crystalline basement. The BB can be divided into an upper deposit derived from primary crater material resting upon a basal polymict layer with an increasing content of local material. The occurrence of fluid/plastic flow textures and plastic deformation features in samples is marked to the left of the columns.