phy is discontinuous and locally incomplete (Figs. 6 and 8). An increase of particles from lower stratigraphic levels of the pre-impact section was found in the polymict, finer grained Bunte Breccia going from bottom to top (SCHNEIDER, 1971). He also observed an increase of the number of shocked particles in the same direction.

The thickness of the ejecta blanket is locally very variable according to the pre-impact relief of the ground zero surface. The average thickness of Bunte Breccia ranges from 80 m near the rim (HÜTTNER, 1969) to some few meters in a radial distance of 35 km (GALL, 1974; GALL et al., 1974). Locally up to 140 m of Bunte Breccia was found in a radial distance of 22 km from the center of crater (BIRZER, 1969). Textural, stratigraphic and grain size properties of the few distant occurrences of Bunte Breccia north of the crater where the post-Riesian erosion is most pronounced indicate that the primary distribution of Bunte Breccia must have been more or less centrosymmetrical with respect to the crater up to a radial distance of more than 40 km (GALL et al., 1974). On the basis of an average thickness of Bunte Breccia of 20 to 25 m, as indicated by the field geology (GALL et al., 1974) we have to expect a volume of 110 to 138 km³ deposited between the radii of 11 km (primary rim area) and 42 km. According to the currently used excavation models and to the reconstructed primary cross section of the crater the displaced volume which contributed to the ejecta blanket beyond the rim, should be in the order of 190 km³ (STÖFFLER et al., 1974). About 5—8 km³ of this volume accounts for the high velocity ejecta (vapor and melt) part of which may have been deposited beyond the vicinity of the continuous ejecta blanket.

III. Description of outcrops and quarries in the Ries area

By

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1. Holheim, Siegling quarry. Quarry in operation at the southwestern rim near Holheim, 4 km SW of Nördlingen. In the lower part of the quarry highly shattered and brecciated Upper Jurassic limestone is exposed, which probably belongs to an allochthonous huge block. This block is covered by Bunte Breccia, mainly gray shales of the Middle Jurassic (Dogger α). The surface of the limestones has been polished and scratched by the movement of the Bunte Breccia. The direction of the movement as to be seen from the grooves was radially outward from the center of the Ries.

2. Harburg, Märker quarry. Quarry in Upper Jurassic limestone (cement factory Märker) S of Harburg, at the western slope of the Wörnitz valley, 3 km SE of the rim. The Wörnitz valley, cut into Upper Jurassic limestone, was filled by Bunte Breccia masses ejected from the Ries crater. The main part of these deposits were later eroded by the river draining the Ries basin. Within the quarry Upper Jurassic limestone and Bunte Breccia lining the valley slopes and bottom are exposed. At this place the Bunte Breccia

consists of large masses of the various sedimentary rocks (mainly Upper Jurassic limestone, Middle Jurassic clay, Keuper sandstone) embedded in a fine grained matrix breccia containing also some rock fragments from the crystalline basement.

3. Ronheim, Bschor quarry. The quarry, situated at the southeastern rim near Harburg, is operated within shattered autochthonous Upper Jurassic limestone (Malm Delta-Dickbänke). The top of the limestone has been polished and scratched by Bunte Breccia which now overlays the limestone surface. The striations within this surface are directed toward the center of the Ries basin. The Bunte Breccia, approximately 5 to 10 m thick, consists of fragments of crystalline rocks, shales and sandstones of the Upper Triassic (Keuper), sandstones of the Middle Jurassic (Dogger), limestones of the Upper Jurassic (Malm) and sands of the Tertiary. The grain size of the fragments is broadly variable. Blocks of granitic rocks up to several meters in diameter have been observed. The crystalline inclusions have been shocked up to stage II. No real shock effects have been observed in the sandstone fragments. A shatter-coned granite fragment has been found recently.

4. Nördlingen, Leopold-Meyers-Keller. Exposure of a polymict crystalline breccia in the southern outskirts of the city of Nördlingen (Galgenberg). The crystalline breccia is underlain by Bunte Breccia and covered by Upper Miocene fresh water limestone. The breccia consists of fragments of various basement rocks: 16% granites, 33% gneisses of dioritic to granodioritic composition and 51% amphibolites. 3% of the fragments show no indication of shock, 48% belong to shock stage I and 49% to shock stage II (ABADIAN, 1972).

5. Gundelsheim, Teich quarry. Autochthonous Upper Jurassic limestone (Malm Delta — Dickbänke) with a polished surface and Bunte Breccia on top of it are exposed within this quarry which is about 8 km ENE of the crater rim. The striations of the limestone surface again point toward the center of the Ries. Bunte Breccia, up to 7 m thick, consists of a matrix of yellow-brown to gray clays of the Tertiary, in which fragments of Upper Jurassic limestone and Tertiary shales up to several meters in diameter are embedded. Fragments of crystalline rocks and Triassic sediments are very rare. Some Jurassic limestone fragments are well-rounded. The crystalline rock inclusions belong to shock stages 0—II. Note the increasing amount of pre-Ries surface rocks incorporated into the Bunte Breccia as the distance from the crater rim increases (SCHNEIDER, 1971).

6. Otting, Märker quarry. Suevite quarry in operation, NW of the village Otting, 5 km E of Wemding and the rim. The contact between the underlying Bunte Breccia and the suevite is exposed in the southern part of the quarry. The boundary dips to the N. In the northern part of the quarry the thickness of suevite amounts to about 25 m. A chilled zone at the base of the suevite, about 1 m thick, is exposed in the southern part of the quarry. In the northern part the upper chilled zone, some meters thick, is preserved. Both chilled zones are characterized by glassy bombs which are not devitrified.