Table 1. Stages of progressive shock metamorphism of crystalline rocks from the Ries crater according to STÖFFLER (1971a).

Stage	peak pressure in kbar	postshock temperature in °C	Post-shock effects in quartz, feldspar or total rock	Textural properties of the rock fragments in the breccias
I	≃ 100	≃ 100	Diaplectic crystals with planar deformation structures (isotropic lamellae) parallel to crystallographic planes and with lowered density, refractive index and birefringence. Stishovite within quartz	Primary texture of the rock is preserved. Intense fracturing
II	≃ 350	≃ 300	Diaplectic glasses as pseudomorphs of quartz and feldspar grains. Coesite and stishovite within diaplectic quartz glass	Primary texture preserved, but clouded appearance of the framework silicates
III	≃ 450	≃ 900	Normal feldspar glass with vesicles and flow structures. Diaplectic quartz glass, coesite (and sometimes traces of stishovite) within diaplectic quartz glass	Primary texture partially destroyed by selective melting. Porous or pumice-like texture
IV	≃ 550 —600	≃ 1300 —1500	Total melting of all mineral phases and mixing of the melts. Remnants of isolated quartz and feldspar glasses with vesicles and flow structures	Primary texture totally destroyed, aerodynamically-shaped glassy bombs
V	> 800	> 3000	Silicate vapor	

The existence of zones or stages of progressive shock metamorphism in the crystalline basement rocks of the Ries crater was first discovered in the crystalline inclusions incorporated in the suevite breccia. Suevite was found to contain a chaotic mixture of rock fragments of different degrees of shock which had been ejected from different depths of the basement (STÖFFLER, 1965, 1966; CHAO, 1968). On the basis of the observed shock effects in quartz and feldspar these rocks could be classified into 5 main stages of shock metamorphism which are described in Table 1. CHAO (1968) proposed a somewhat different classification for the granitic rock suite of the Ries crater. The concept of classification given in Table 1 which is applicable to all dense, crystalline rocks (STÖFFLER, 1971) is important for the interpretation of the origin and excavation mechanics of the various types of impact formations which have been found in the Ries area (see VON ENGELHARDT in Part I).

Characteristics of the distribution of the Ries ejecta formations

As discussed by W. von Engelhardt in the first part of this paper the impact formations of the Ries crater can be classified into two main types:

a) *Bunte Breccia* in the widest sense represents the majority (probably more than 95%) of the ejecta blanked mass of the crater. Bunte Breccia comprises different subgroups such as the large, monomict shattered blocks or masses of sedimentary or crystalline rocks, the polymict crystalline breccias, and the more fine-grained Bunte Breccia sensu stricto into which the former two groups may be incorporated.

b) *Suevite* and *impact melt rocks*. Suevite consists predominantly of fragments of crystalline rocks of all possible stages of shock metamorphism. 20—75% of these inclusions are shock melted rocks. Suevite and the rare coherent masses of recrystallized melt rocks exposed near Polsingen and Amerbach represent the highly shocked central part of the crater. This is only a small percentage of the total displaced mass.

Both types of impact formations occur in the ejecta blanket ouside the crater and in the fallback material inside the crater as well though their composition is different in both locations. The presence of a suevite blanket on top of the fallback material is known from the drilling cores of Deiningen (depth: 350 m) and of Nördlingen (depth: 1206 m). This suevite has a fragmental matrix without glass; only a few of the abundant coarser inclusions are shock melted rocks. The throwout suevite, however, is characterized by a glass-rich fragmental matrix and a high abundance of molten rock inclusions which form typical glassy bombs.

The Bunte Breccia inside the crater below the suevite blanket is a crystalline rock breccia which is almost free of Jurassic and Triassic sedimentary rocks. Its counterpart in the throwout ejecta blanket consists mainly of large blocks and smaller fragments of sedimentary rocks with a small admixture of crystalline rocks which may be shocked up to stage II (Table 1). In a zone between the inner ring of uplifted crystalline rocks and the present morphological rim (compare Engelhardt in part I) the ejecta material is extremely blocky. The "megablocks" are mainly derived from the sedimentary strata. They are mixed together with a few blocks of crystalline rocks with finer grained Bunte Breccia which also contains pockets or dikes of polymict breccias (Abadian, 1972). Probably this zone represents the primary rim area which upon excavation of the crater was structurally deformed by slumping and faulting because of the isostatic readjustment of the crater. Thereby secondary uplifting of the inner ring of crystalline rocks may occur which enhances a possible primary uplifting produced during cratering as a result of a change of the particle motion at the density discontinuity between sedimentary and crystalline basement rocks.

The continuous ejecta blanket outside the crater may be characterized by a typical horizontal and vertical variation of some compositional and structural properties (Fig. 6).

From the present surface geology of the ejecta blanket it is inferred that only the Upper Jurassic rocks are represented throughout the whole blanket.