SUPERIMPOSED PROCESSES IN CHONDRULES OF THE OKHANSK METEORITE

A.I. Bakhtin, R.Kh. Sungatullin, A.V. Gusev, A.A. Eskin, D.M. Kuzina
Kazan Federal University, Institute of Geology and Petroleum Technologies, Russia, Kazan
E-mail: Rafael.Sungatullin@kpfu.ru

Introduction

The Okhansk meteorite belong to group of olivine-bronzite H-chondrites [1-3]. It is intensively brecciated and is represented by a disorderly mixture of silicate chondrules, their breaks and their fine-grained matrix enclosed by silicate minerals, interstitial silicate glass and ore minerals (kamacite, troilite). The chondrules fill about one third of the meteorite volume. Their size is usually 0.2-0.9 mm (Fig. 1). They consist of olivine, bronzite, diopside, plagioclase. Often they contain silicate glass.

Methods

In study of the Okhansk meteorite we used following methods and instruments: 1) microprobe analysis on scanning electron microscope XL-30 from Philips with EDAX; 2) X-ray fluorescence analysis on the Bruker S8 Tiger analyzer; 3) X-ray diffraction analysis on P2 Phaser diffractometer from Bruker; 4) crystal-optical study of petrographic sections on microscope from Zeiss; 5) ThermoGravimetry (TG) - Differential Scanning Calorimetry (DSC) Analyser STA/TG-DSC NETZSCH STA 449 F3.

Results

The following processes were identified that participated in formation of chondrules: 1) cooling and recrystallization of melts formed during melting of ProtoSolar Nebula substance as result of Supernova explosion in its vicinity; 2) collisions of chondrules and initial melts with each other; 3) high-temperature autometasomatic transformations in chondrules; 4) superimposed low-temperature processes (Fig. 2, 3): hydrocarbonization, carbonatization, silicification, serpentinization, chloritization.

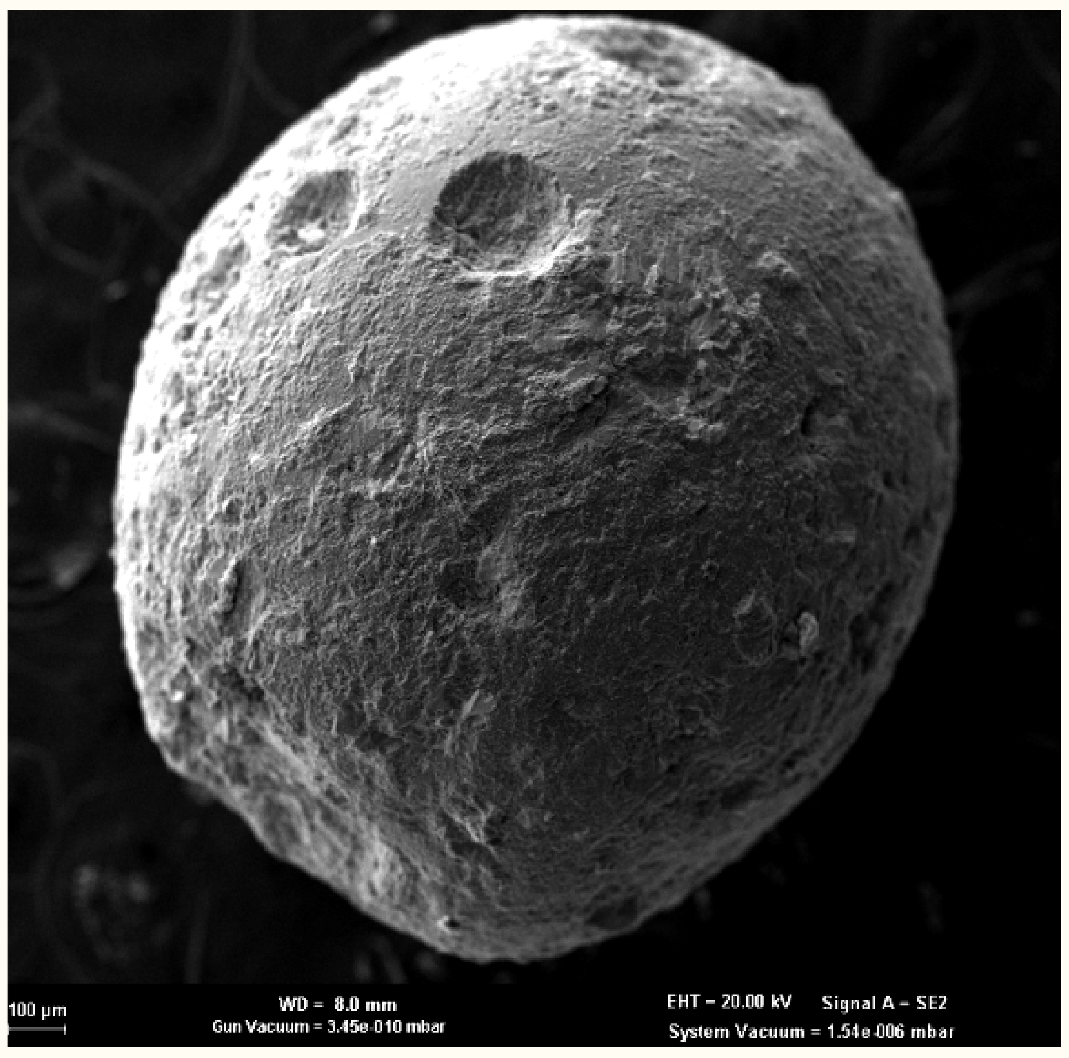

Fig. 1. Pyroxene-olivine-plagioclase chondrule

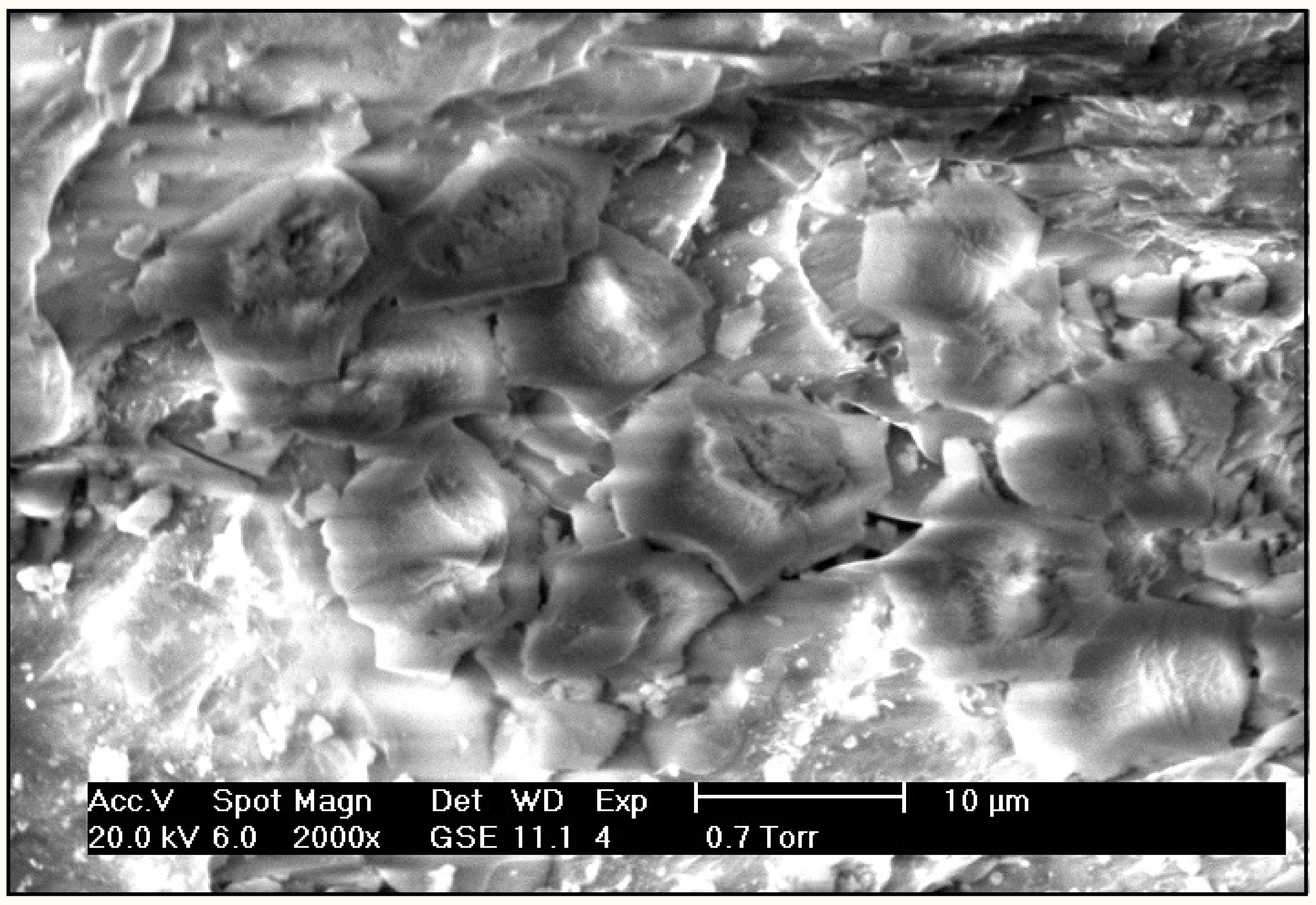

Fig. 3. Nest-like release of carbonates on chipped of olivine chondrule

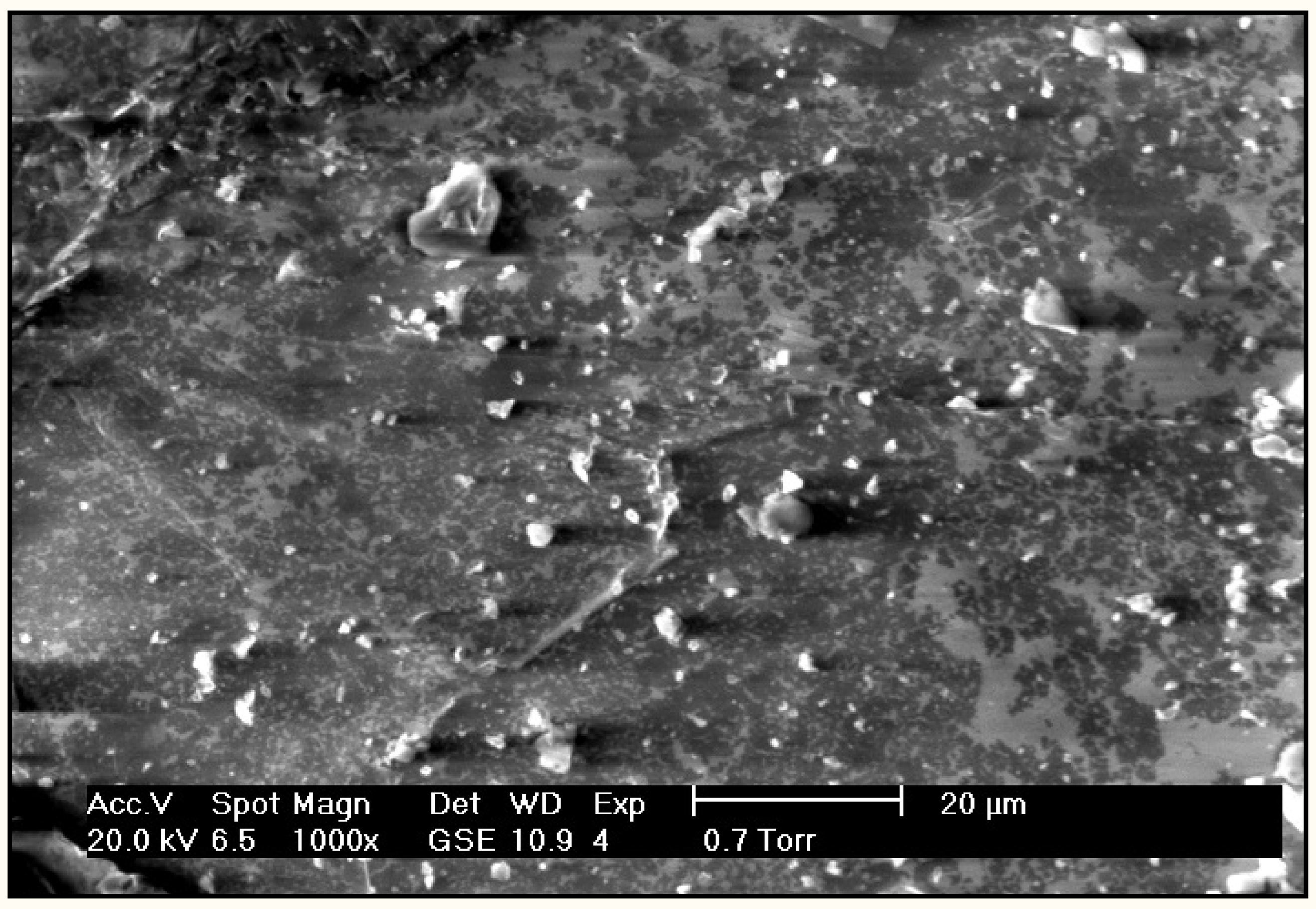

Fig. 2. Carbon-containing (light gray) and carbon-free (dark gray) areas on the soldered chipped of olivine in chondrule

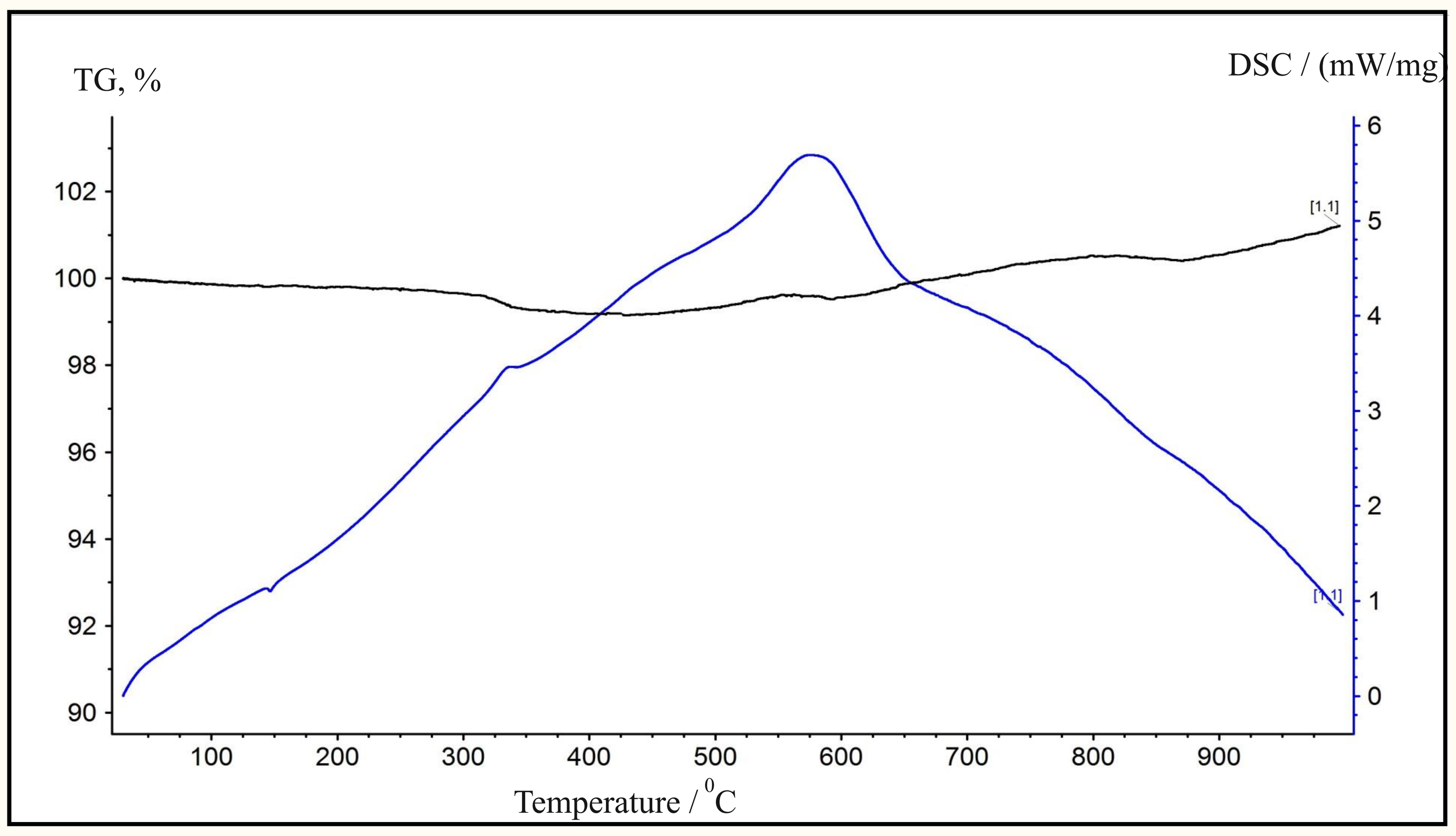

Fig. 4. TG and DSC results

Discussions: The stationary cooling mode of chondrite melts caused formation of the dominant granular structures for chondrules in the Okhansk meteorite. Less common are the radiant (Fig. 1), grate and glassy structures of chondrules, indicating their formation from supercooled silicate melts. When a chondrules collide, oval dents are noted on their surface, and cracks appear inside the chondrules, which are sometimes filled with residual melts of the impacting chondrules, causing glassy and microgranular veinlets and nests in chondrules. The residual silicate melts cause high-temperature autometasomatic transformations in chondrules: orthopyroxene develops on olivine, and clinopyroxene (diopside) develops on orthopyroxene. Low-temperature superimposed processes in chondrules were expressed in formation of calcite, magnesite, quartz, serpentine, chlorite, and accumulations of hydrocarbons. The latter showed effect of “boiling” - gas emission under the action of microscope electron beam, and in thermal analysis of bitumen accumulation generated an exothermic peak on DSC curve and weight loss on TG curve at 330ºC (Fig. 4). The thermograms also show the effects of serpentine dehydration (150°C), dissociation of magnesite, chlorite (595°C), and calcite (870°C).

Conclusions: The chondrules and Okhansk meteorite substance underwent secondary low-temperature (hydrothermal) transformations.
t can be assumed that the substance of future Okhansk meteorite was located in near-surface zone of parent body, in which the processes of internal differentiation of its substance took place, and in its near-surface part they were expressed in development of hydrothermal processes with addition of H_2O, CO_2, CO, Si, Ca, Mg, K, Na and hydrocarbons. These processes led to the hydrocarbonization, carbonatization, silicification, serpentinization, chloritization.

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