SMALL, YOUNG VOLCANIC DEPOSITS AROUND THE LUNAR FARSIDE CRATERS ROSSELAND, BOLYAI, AND ROCHE. J. H. Pasckert[1], H. Hiesinger[1], and C. H. van der Bogert[1]. [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany. jhpasckert@uni-muenster.de

Introduction: To understand the thermal evolution of the Moon it is essential to investigate the volcanic history of both the lunar near- and farside. While the lunar nearside is dominated by mare volcanism, the farside shows only some isolated mare deposits in the large craters and basins, like the South Pole-Aitken basin or Tsiolkovsky crater [e.g., 1-4]. This big difference in volcanic activity between the near- and farside is of crucial importance for understanding the volcanic evolution of the Moon. The extensive mare volcanism of the lunar nearside has already been studied in great detail by numerous authors [e.g., 4-8] on the basis of Lunar Orbiter and Apollo data. New high-resolution data obtained by the Lunar Reconnaissance Orbiter (LRO) and the SELENE Terrain Camera (TC) now allow us to investigate the lunar farside in great detail.

Basaltic volcanism of the lunar nearside was active for almost 3 Ga, lasting from ~3.9-4.0 Ga to ~1.2 Ga before present [5]. In contrast to the nearside, most eruptions of mare deposits on the lunar farside stopped much earlier, ~3.0 Ga ago [9]. However, [9] also found mare deposits that show much younger ages of 2.5 Ga. Consequently, [9] concluded that the farside volcanism might have occurred episodically, around 2.5 Ga and between 3.0 Ga and 3.6 Ga. However, they pointed out that the absence of volcanic deposits with ages between 2.5 and 3.0 Ga might also be explained by continuous resurfacing by younger deposits. [9] argued that the relatively large difference in the cessation of volcanic activity between the nearside (1.2 Ga) and farside (2.5 Ga) might be related to a larger crustal thickness on the lunar farside, which hinders the lava eruption.

Our study area is located between the Australe and South Pole-Aitken basins, south of Tsiolkovsky crater at the southern lunar farside (Fig. 1). According to the geological map of Wilhelms and El-Baz from 1977 [1], this region is dominated by craters and basin materials of Pre-Nectarian and Nectarian age. The most prominent mare basalts are located inside Pauli crater in the east and Tsiolkovsky crater in the north. The geological map of Wilhelms and El-Baz [1] also shows some small mare patches in Roche and Bolyai crater and west of Rosseland crater on the western side of our study area (Fig. 1, 2). We chose this area to investigate the volcanic history of a relatively old region with a presumably thick crust. In addition, the volcanic deposits of this area are much smaller than most of the mare basalts on the near- and farside. This gives us the opportunity to investigate the history of small scale volcanism on the lunar farside.

Figure 1: Our study area, shown as a white box on the geological map of [1], encompassed small mare deposits (magenta) in and around Rosseland, Bolyai, Roche, and Pauli crater. The floor of Rosseland crater (white star) is mapped as light plains.

Data: We used data from the LRO Wide Angle Camera (WAC: 100 m/pixel), Narrow Angle Camera (NAC: 1 m/pixel), and the Kaguya Terrain Camera (TC) (10 m/pixel) to identify and map individual volcanic deposits and to perform crater size-frequency distribution (CSFD) measurements. The combination of the global WAC mosaic with the FeO map of Lucey et al. (2000) [10] (100 m/pixel) based on Clementine data, was used to identify and map individual basaltic deposits.

Results: On the basis of WAC and TC images we were able to map the crater floor of Rosseland crater in more detail than Wilhelms and El-Baz [1] (Fig. 2). We found seven separate FeO-rich volcanic deposits (FeO: up to 18 wt%) inside Rosseland crater between the central crater floor and the crater wall. The absolute model ages of four of these deposits vary between 2.2

Ga and 2.9 Ga (Fig. 2). We also identified FeO-rich volcanic deposits (FeO: up to 17 wt%) inside a crater north of Rosseland crater with an absolute model age of about 2.1 Ga (Fig. 2).

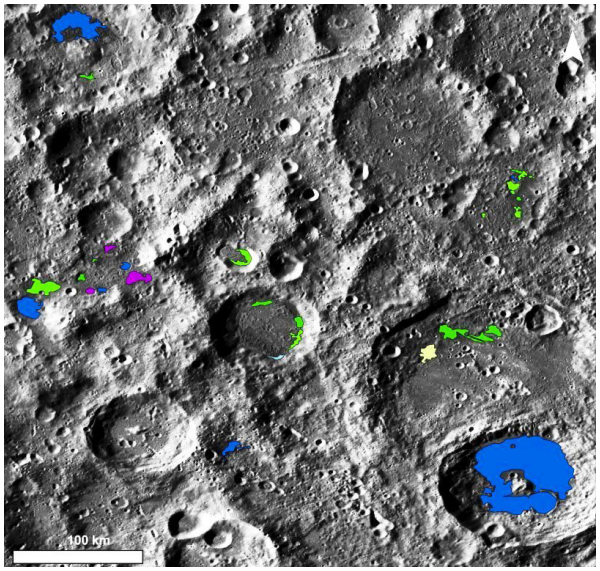

Figure 2: Mapped volcanic deposits within the study area (green: 1.8 - 2.6 Ga; blue: 2.7 - 3.6 Ga; violet: > 3.7 Ga) .

The volcanic deposits on the western side of the study area exhibit absolute model ages between 2.1 Ga and 3.8 Ga and show a FeO content of up to 18 wt%. Another FeO-rich (up to 18 wt%) volcanic deposit could be identified south of Rossland crater. Our CSFD measurements of this unit show an absolute model age of 3.3 Ga, which is similar to the deposits on the western side of our study area. The volcanic deposits inside Bolyai crater at the northern edge of our study area have an absolute model age of 3.5 Ga. The relatively large mare basalts in Pauli crater show FeO contents of about 20 wt%, and our CSFD measurements reveal an absolute model age of about 3.2 Ga. The mare basalts in Roche crater are much smaller and have similar FeO contents (up to 18 wt%). The absolute model ages of these deposits show significantly younger ages of ~2.3 Ga. We also mapped the volcanic deposits north of Roche crater, which have already been mapped by [1], in much more detail. We identified 10 separate mare deposits, which vary in age between 1.8 Ga and 3.1 Ga. The FeO content of these deposits show variations from 10 to 17 wt%, similar to all other deposits investigated.

Discussion and Conclusions: Our investigation shows that the studied area was volcanically active over a very long time period (1.8 Ga to 3.8 Ga). In general, this is in good agreement with studies by [9, 11] of other volcanic regions on the farside. [9] and [11] found absolute model ages of farside mare basalts, such as those in Moscoviense and Apollo crater, to range from 2.1 Ga to 3.8 Ga. While the oldest volcanic activity in our study area is in the same range, the youngest activity is younger by ~300 Ma. In addition, most of the mare basalts investigated by [9, 11] have ages of about 3.4 Ga, while the volcanic deposits in our study area show a peak (Fig. 3) at about 2.4 Ga.

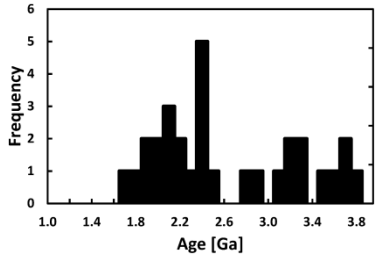

Figure 3: Histogram of the model ages of the volcanic deposits in our study area.

However, most of the younger mare deposits that we investigated are relatively small (< 20 km^2). The effect of the size of a counting area on the uncertainty of the model ages is still debated. Consequently, the quality of the young ages of about 2 Ga and younger, might be affected by their small counting areas. To get a better understanding of the effect of the counting area size on the absolute model ages, we performed crater counts of the mare basalts inside Tsiolkovksy crater while varying the size of the counting areas. Our preliminary results showed, that the absolute model age does not change significantly when scaling down the counting area from 200 km^2 (3.40±0.03 Ga) to 4 km^2 (3.41±0.22 Ga), using craters of a diameter > 150m. Hence, the small size of our counting areas does not seem to influence the young absolute model ages.

References: [1] Wilhelms and El-Baz (1977) Geologic Map of the East Side of the Moon, *I-948*. [2] D. E. Stuart-Alexander, U.S. Geol. Surv. Map I-1047 (1978). [3] A. S. Walker, F. El-Baz, *Moon Planets* 27, 91 (1982). [4]Wilhelms D.E. (1987) The geologic history of the Moon, *USGS Prof. Pap. 1348*, 302 pp. [5] Hiesinger H. et al. (2011) Ages and stratigraphy of lunar mare basalts: A synthesis, *The Geol. Soc. of A. Spec. Paper 477*. [6] Hiesinger H. et al. (2000) Ages of mare basalts on the lunar nearside, *J. Geophys. Res, Vol. 105*. [7] Hiesinger H. et al. (2003) *JRL, 108*. [8] Bugiolacchi R. and Guest J.E. (2008) *Icarus, 197*, 1–18. [9] Haruyama et al. (2009) Long-lived volcanism on the lunar farside revealed by SELENE Terrain Camera, *Science Vol. 323*. [10] Lucey P. G. et al. (2000) *J. Geophys. Res. 105*. [11] Morota et al. (2011) Timing and duration of mare volcanism in the central region of the northern farside of the Moon, *Earth Planets Space, 63,* 5-13.