Exploration of the ^{60}Ca region

O. B. Tarasov,[*1,*2] T. Kubo,[*1,*2] D. Bazin,[*1,*2] D. J. Morrissey,[*1,*2] M. Portillo,[*1,*2] B. M. Sherrill,[*1,*2] A. Stolz,[*1] M. Thoennessen,[*1] D. S. Ahn,[*2] H. Baba,[*2] N. Fukuda,[*2] N. Inabe,[*2] S. Ishikawa,[*2,*3] N. Iwasa,[*2,*3] K. Kawata,[*2,*4] T. Komatsubara,[*2] K. Kusaka,[*2] M. Ohtake,[*2] H. Otsu,[*2] T. Sakakibara,[*2,*3] H. Sakurai,[*2] H. Sato,[*2] Y. Shimizu,[*2] T. Sumikama,[*2] H. Suzuki,[*2] H. Takeda,[*2] H. Ueno,[*2] Y. Yanagisawa,[*2] and K. Yoshida[*2]

The discovery of new nuclei in the proximity of drip lines is an important benchmark for nuclear mass models, and hence for the understanding of nuclear force and modeling the creation of elements. Recent measurements at the NSCL[1,2] have demonstrated that the fragmentation of ^{76}Ge and ^{82}Se beams can be used to produce new isotopes (NI) in the calcium region. This work was extended at RIKEN using higher energy and intensity in April–May 2017, when the NP1406-RIBF44R1 experiment was carried out.

A 345 MeV/nucleon ^{70}Zn beam with an intensity of 225 pnA, which was accelerated by the RIKEN RIBF accelerator complex, was fragmented in a series of beryllium targets placed at the object position of the BigRIPS fragment separator.[3]

The experimental conditions for the NI production runs are listed in Table 1. These settings were centered on ^{50}S, ^{53}Cl, ^{54}Ar, ^{57}K, and ^{60}Ca based on LISE^{++} calculations.[5] Two aluminum wedge-shaped degraders at the F1 and F5 dispersive planes were used at full BigRIPS momentum acceptance to separate and purify the RI beams.

The particle identification (PID) was conducted using the ToF-$B\rho$-ΔE-TKE method described in the appendix to the previous work.[6] Figure 2 shows the preliminary Z vs. A/q PID summary plot for all NI production runs. We observed a total of 9 new neutron-rich nuclei during the 100 hours of NI search: ^{47}P, ^{49}S, ^{52}Cl, ^{54}Ar, ^{57,59}K, ^{59,60}Ca, ^{62}Sc.

Production cross sections, secondary reaction contributions, and momentum distributions runs were performed. The data are under analysis.

Table 1. Experimental conditions for NI production runs.

Settings	^{50}S	^{53}Cl	^{54}Ar	^{57}K	^{60}Ca
Target(Be) [mm]	20	15	10	10	15
$B\rho$01 [Tm]	7.35	7.8	8.0	8.0	7.35
F1 degrader [mm]	3	3	3	3	3
F5 degrader [mm]	3	1	1	1	3
Time [h]	8.9	23.5	11.2	17.0	38.9

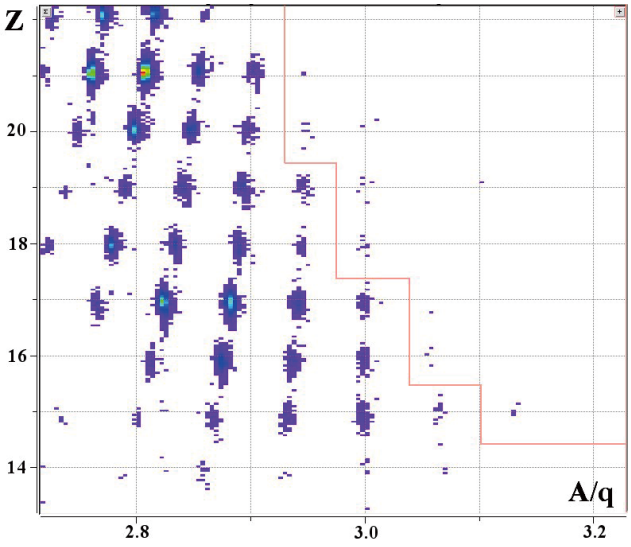

Fig. 2. PID plot of NI production runs.

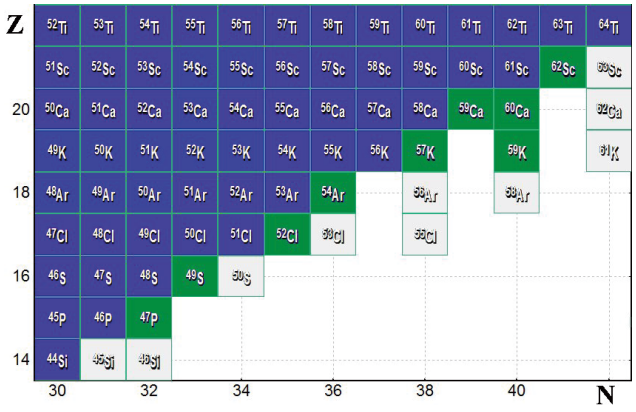

Fig. 1. The region of the chart of nuclides studied. The solid line is the limit of bound nuclei from the KTUY mass model.[4] The nuclei in the green squares were newly observed in this work.

*1 NSCL/FRIB, Michigan State University
*2 RIKEN Nishina Center
*3 Department of Physics, Tohoku University
*4 Center for Nuclear Study, University of Tokyo

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