1 Introduction

In this paper we have analyzed by neutron activation analysis (NAA) a number of 93 items of Neolithic copper from National Museum of History from Bucharest, having the provenance from Moldavia region. In the Table 1 it is shown the list of analyzed objects.

2 Experimental method of analysis

We have applied the NAA, the particular features of the method encountered for ancient copper being also detailed in reference 1.

Sampling. First some corroded parts have been removed from the surface of copper objects, the corroded material having a totally different elemental composition from that of the body of the object. Then samples of 10-50 mg have been cut with a hard vidia knife from the object body and after that washed with different solvents:
acetone, benzene, ether to avoid the impurities from the surface of the item and the protective varnish, added in the museum.

**Irradiation of medium periods.** Samples have been put in polyethylene foils and irradiated at the rabbit system of the nuclear reactor VVR-S, from NIPNE Magurele, Bucharest at the flux of \( \approx 1.25 \times 10^{12} \) neutrons/cm\(^2\)-sec, for 30 minutes. Copper being in majority it was strongly activated so that the induced radioactivity in the samples could be measured only after 4-5 days. Natural cooper has 2 isotopes: Cu\(^{63}\) and Cu\(^{65}\) which by the reaction \((n, \gamma)\) give the radioisotopes Cu\(^{64}\) \(T_{1/2}=12.74 \) h and Cu\(^{66}\) with \(T_{1/2}=5.10 \) min. After a cooling time of 4-5 days, in the gamma spectra of the samples, the activity coming from the photopeak of 1345.8 keV (0.0048) of Cu\(^{64}\) is small enough and permits to remark other elements, present in the cooper matrix. The samples have been measured 1000 s at a spectrometric chain using a Ge(Li) detector of 135 cm\(^3\) and an analyzer of 4096 channels coupled at a PC. The system gave a resolution of 2.7 keV at 1.33 keV (Co\(^{60}\)). We observed the elements: Au, As, Cu and Sb.

**Long time irradiation:** The samples of copper have been wrapped in aluminum foil and put it in a quartz phial together with metallic spectroscopic pure standards, copper and nickel and irradiated at the vertical chain of the reactor, at a flux of \( \approx 10^{13} \) neutrons/cm\(^2\)-sec, for a period of time of 40 h. After a cooling time of 2 weeks, we measured the \(\gamma\) activity of the samples at the same spectrometric chain, for 3000 s. We have determined the following elements: Sb, Ag, Co, Cr, Fe, Hg, Ni, Se, Sn.

**Cobalt.** Cobalt was determined in the copper object using the isotope Co\(^{60}\) got in the reaction: Co\(^{59}\)(n, \(\gamma\))Co\(^{60}\). Co\(^{60}\) is also produced by the reaction: Cu\(^{63}\)(n, \(\alpha\))Co\(^{60}\) which is important enough in this situation, when the element copper is the major element (\(\approx 99\%\)). So that \(C_{Co} = C_{total} - C_{Cu}\), where \(C\) is the concentration. Another correction made in the calculus of the cobalt concentration in the copper samples is that the used cooper standard contains also traces of cobalt. It was
determined that a standard of pure copper has a content of minimum 4 ppm of cobalt. Also in the gamma background of the experimental room it were observed the peaks at the cobalt energies of 1773.2 keV and 1332.5 keV; therefore from the respective photopeaks area it was subtracted the area given by the background, measured for the same period of time as the sample.

**Mercury** was determined from the $\gamma$ ray of 279.2 keV and intensity (81.5%) of Hg$^{203}$ with $T_{1/2}=46.60$ d. This ray is interposed with the $\gamma$ ray from Se$^{75}$, of 279.5 keV, and intensity 0.25. Therefore the contribution of the mercury must be extracted from the peak of peak of 279 keV: $N_{Hg^{203}}=N_{total279keV} - N_{Se^{75}}$, where $N_{Hg^{203}}$ is the counting rate in the peak of 279 keV, given by mercury contribution. $N_{total279keV}$ is the total counting rate in the peak of 279 keV $N_{Se^{75}}$ is the counting rate in the peak of 279 keV, due to the selenium presence.

It was used as reference the selenium peak from the energy 264.7 keV of intensity of 0.5658:

$$\epsilon_{264keV} \cdot s_{264keVSe^{75}} \cdot N_{264keVSe^{75}} = \epsilon_{279keV} \cdot s_{279keVSe^{75}} \cdot N_{279keVSe^{75}}$$

where: $\epsilon_{264keV}$ is the efficiency of the detector from 264 keV, $\epsilon_{279keV}$, is the efficiency at the energy of 279 keV, $s_{264keVSe^{75}}$, the intensity of the line of 264 keV of Se$^{75}$, $s_{279keVSe^{75}}$, the intensity of the line of 279 keV of Se$^{75}$.

**Nickel.** The concentration of nickel was measured by the isotope Co$^{58}$ ($T_{1/2}=71.3$ d). Nickel was a exception by the fact that it was determined by the reaction Ni$^{58}$(n, p)Co$^{58}$, unlike the other elements determined by the reaction (n, $\gamma$).

3 Results of analysis

In the Table 2 are given the results of activation analysis for the Neolithic copper objects, from the National Museum of History from Bucharest. The concentrations are given in ppm, and when an element was determined in a quantity larger than
10000 ppm, its concentrations was expressed in percents, using the notation of %. The measured errors were the statistical errors and were in mean of <10%. In the situations when the signal was dimmed by the background $\gamma$ Compton the result was given as -, with the significance of under the limit of detection.

The NAA provides the values of the concentrations for the determined elements in the Neolithic copper objects that establish a basis for further characterizations and interpretations together with the considerartion of historic data as culture, dating or style.

Acknowledgement

We thank archaeologist Dragomir Popovici for collaboration.
References

1. Agata Olariu, C. Besliu, M. Belc, I. V. Popescu, T. Badica, Compositional Studies of Ancient Copper from Romanian Territories, Los Alamos e-print Archive, nucl-ex, paper 9907015, and Journal of Radioanalytical and Nuclear Chemistry, 1999
Table 1. List of analyzed Neolithic copper objects, National Museum of History Bucharest

| Sample | Object of copper       | Reg. no. | Hoard, provenance                  |
|--------|------------------------|----------|------------------------------------|
| P1     | Axe-Pick-axe           | 170      | Central Military Museum            |
| P2     | Axe                    | 169      | Central Military Museum            |
| P3     | Axe                    | 170      | Central Military Museum            |
| P4     | Axe                    | 36241    | Central Military Museum            |
| P5     | Copper object          | 6        | Vaslui Museum, Fedesti Cetate      |
| P6     | Needle                 | 13444    | Vaslui Museum, Dumesti             |
| P7     | Needle                 |          | Malnas, Cucuteni A                 |
| P8     | Axe of copper          |          | Fastici, Vaslui county (Import?)   |
| P9     | Needle (?)             | 94       | Malnas                             |
| P10    | Bead frag.             |          | Brad hoard, Bran Museum            |
| P11    | Bracket                | 17579    | Brad hoard                         |
| P12    | Bracket                |          | Brad hoard                         |
| P13    | Bracket                | 17578    | Brad hoard                         |
| P14    | Axe                    |          | Brad hoard                         |
| P15    | Bracelet               | 17577    | Brad hoard                         |
| P16    | Bracelet               | 17576    | Brad hoard                         |
| P17    | Rite (?) axe           | 17575    | Brad hoard                         |
| P18    | Axe-Pick-axe           | 740      | Slobozia-Bodoganesti, Museum Complex Iasi |
| P19    | Axe                    |          | Erbicieni, Iasi county             |
| P20    | Chisel                 | 11145    | Rus/81, Rusaesti-Poduri, Piatra Neamt |
| P21    | Needle                 | 11143    | Rus/81, Rusaesti-Poduri            |
| P22    | Needle (?)             | 11143    | Rusaesti-Poduri                    |
| P23    | Metallic frag.         | 11142    | Rusaesti-Poduri                    |
| P24    | Needle                 | 11146    | Rusaesti-Poduri                    |
| P25    | Needle                 | 11148    | Rusaesti-Poduri                    |
| P26    | Metallic sheet         | 11141    | Rusaesti-Poduri                    |
| P27    | Needle                 | 11147    | Rusaesti-Poduri                    |
| P28    | Needle of copper       | 11144    | Rusaesti-Poduri                    |
| P29    | Frag. of bead          | II 14910-6395 | Traian, 1953, Neamt county        |
| P30    | Needle                 | 6443     | Traian, 1957                       |
| Sample | Object of copper        | Reg. no. | Hoard, provenance                      |
|--------|-------------------------|----------|----------------------------------------|
| P31    | Needle                  | 894      | Izvoare 1939, Neamt county             |
| P32    | Needle                  | 894      | Izvoare 1939                          |
| P33    | Needle                  | 894      | Izvoare 1939                          |
| P34    | Needle                  | 894      | Izvoare 1939                          |
| P35    | Piece of copper         | 1615     | Izvoare                                |
| P36    | Metallic frag.          | 1544     | Podei, Tg. Ocna                       |
| P37    | Small bead              | 6394     | Traian, 1952                          |
| P38    | Needle                  | 1543     | Podei, Tg. Ocna 1943                  |
| P39    | Needle                  | 6440     | Traian, 1950                          |
| P40    | Needle                  | 6440     | Traian, 1957                          |
| P41    | Needle                  | 6438     | Traian 1956                           |
| P42    | Needle                  | 6439     | Traian, 1952                          |
| P43    | Needle                  | 6445     | Traian 1957                           |
| P44    | Needle of ornament      | 6370     | Tarpesti, Neamt county 1963           |
| P45    | Spiral needle for hair  | 6374     | Tarpesti 1963                         |
| P46    | Wire                    | 6608     | Tarpesti 1962                         |
| P47    | Dagger                  | 1330     | Frumusica, Neamt county               |
| P48    | Link                    | 15526    | Rusaesti/86, cassette A                |
| P49    | Needle                  | 6609     | Tarpesti, 1963                        |
| P50    | Needle                  | 6615     | Tarpesti, 1965                        |
| P51    | Frag. of copper         | 6617     | Tarpesti, 1963                        |
| P52    | Frag. of needle         | 6590     | Tarpesti, 1962                        |
| P53    | Disk                    | 6593     | Tarpesti L11                          |
| P54    | Frag. of bracelet       | 6595     | Tarpesti, 1964                        |
| P55    | Frag. of bronze         | 6597     | Tarpesti, 1959                        |
| P56    | Frag. of needle         | 6596     | Tarpesti, 1963                        |
| P57    | Frag. angling rod (?)   | 6599     | Tarpesti, 1962                        |
| P58    | Peack                   | 6600     | Tarpesti, 1962                        |
| P59    | Needle frag.            | 6601     | Tarpesti, 1962 L7                     |
| P60    | Miniature Axe           | 6591     | Tarpesti, 1962                        |
| P61    | Brass Needle            | 6613     | Tarpesti, 1968                        |
| P62    | Wire                    | 7923     | Tarpesti, 1968                        |
| P63    | Small brass hook        | 6587     | Tarpesti, 1968                        |
| P64    | Sheet                   | 6594     | Tarpesti, 1963                        |
| Sample | Object of copper          | Reg. no. | Hoard, provenance           |
|--------|---------------------------|----------|----------------------------|
| P65    | Needle                    | 6436     | Traian, 1954               |
| P66    | Frag. bracelet            | 15527    | Poduri-Rusaesti 86         |
| P67    | Needle                    | 6437     | Traian, 1952               |
| P68    | Needle                    | 6444     | Traian, 1958               |
| P69    | Rolled Sheet              | 6453     | Traian, 1952               |
| P70    | Needle for angling rod    | 6407     | Traian, 1957               |
| P71    | Spiral                    | 6452     | Traian, 1952               |
| P72    | Metallic frag.            | 894      | Izvoare, 1939              |
| P73    | Wedding ring              | 6403     | Traian, 1958               |
| P74    | Needle                    | 15528    | Izvoare, 1984 L10          |
| P75    | Needle                    | 894      | Izvoarele                  |
| P76    | Idol "en violon"          | 6451     | Traian, 1952               |
| P77    | Spiral bracelet           | 779      | Izvoare                    |
| P78    | Needle(?)                 |          | Piatra Neamt               |
| P79    | Needle(?)                 |          | Piatra Neamt               |
| P80    | Needle(?)                 |          | Piatra Neam't              |
| P81    | Axe                       | 3292     | Dragomiresti               |
| P82    | Axe passim                | 4697     | Sarata, Piatra Neamt       |
| P83    | Axe                       | 4696     | Viisoara, Manastirea Bistritei |
| P84    | Needle                    | 5594     | Calu 1974, Neamt county    |
| P85    | Frag. metallic            | 2958     | Podei, 1956                |
| P86    | Axe                       | 965      | Floresti, Vaslui county    |
|        |                           |          | Vasile Parvan Museum, Barlad |
| P87    | Axe                       | 964      | Floresti, Vaslui county    |
| P88    | Axe                       | 7034     | Lupesti, Vaslui county     |
| P89    | Axe                       | 7984     | Falciu, novelty, import(?) |
| P90    | Axe                       | 975      | Bacesti, Vaslui county     |
| P91    | Needle of copper          | 8016     | Trestiana, Grivita, Vaslui county |
| P92    | Small bead                | 8543     | Falciu, the same complex to P89 |
| P93    | Small bead                | 8543     | Falciu                      |
Table 2. Concentrations of analyzed Neolithic copper objects, by NAA

| Sample | Au  | As  | Sb  | Se  | Hg  | Cr  | Ag  | Ni  | Fe  | Zn  | Co  | Sn  |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| P1     | 0.1 | –   | 2   | 13  | –   | 133 | 14.6| 130 | 7680| 426 | 3.2 | –   |
| P2     | 0.4 | –   | 3   | 37  | 2   | 219 | 11  | 160 | 1.01%| 708 | 0.9 | –   |
| P3     | 0.2 | 14  | 2   | 162 | 3.4 | 160 | 17  | 430 | 8200| 452 | 29  | –   |
| P4     | 0.3 | –   | 18  | 32  | 2.8 | 110 | 23.5| 150 | 4960| 257 | 1.6 | –   |
| P5     | 0.3 | –   | 1   | 56  | 0.3 | 40  | 11.5| 178 | 298 | 6   | 4.1 | –   |
| P6     | 24.3| –   | 3   | 2   | 12  | 29  | 358 | 197 | –   | 6.9 | 5.3 | 230 |
| P7     | 1.4 | 7.6 | 100 | 60  | 1.4 | 54  | 97  | –   | 6   | 0.6 | –   | –   |
| P8     | 0.2 | –   | 1   | 551 | 84  | 196 | 50  | 250 | 9660| 524 | 3.5 | –   |
| P9     | <0.1| 29.6| 1   | –   | 14  | 70  | 6   | 1.49%| 69  | 1   | –   | –   |
| P10.1  | 13  | –   | 11  | 309 | 1.8 | 518 | 206 | –   | –   | 1.1 | –   | –   |
| P10.2  | 5.1 | 9.2 | 27  | 856 | 3.4 | 236 | 75  | 201 | 1080| 510 | 5.4 | –   |
| P10.3  | 6.4 | 10.7| 4.3 | 300 | 1.6 | 110 | 885 | 200 | 1580| 187 | 1.2 | –   |
| P10.4  | –   | 4.3 | 11  | 329 | 1.7 | 797 | 418 | 150 | 900 | 51  | 0.7 | –   |
| P10.5  | –   | –   | <1  | 1.5 | 6.4 | 20  | 17  | 12  | –   | –   | –   | –   |
| P11    | 15.2| 1380| 2370| 1010| <25 | 828 | 2400| –   | –   | 110 | 3.82%| –   |
| P12    | 2.2 | 5303| 835 | 120 | –   | 182 | 1.72%| –   | –   | 90  | 13.2%| –   |
| P13    | 80  | 173 | 92  | 35  | 2.5 | 153 | 98  | 870 | 7360| 270 | 1.2 | 330 |
| P14    | 1   | 24  | 32  | 24  | 2   | 218 | 134 | –   | 16  | 1.4 | –   | –   |
| P15    | 2.6 | –   | 5   | 370 | 10  | 270 | 885 | 240 | 1.24%| 661 | 4   | 400 |
| P16    | 5.5 | –   | 5   | 395 | –   | 150 | 914 | 190 | –   | 561 | 3   | –   |
| P17    | 2.9 | –   | 0.4 | 4385| –   | 360 | 46  | 278 | 7520| 504 | 1.5 | 620 |
| P18    | –   | –   | <1  | 1.5 | 6.4 | 20  | 17  | 12  | –   | –   | –   | –   |
| P19    | 5.1 | 265 | 260 | 260 | 3.4 | 70  | 370 | 760 | 1.13%| 330 | 2.1 | –   |
| P20    | 0.7 | –   | 3   | 180 | 0.1 | 22  | 195 | –   | 25  | 3.6 | –   | –   |
| P21    | –   | –   | 1   | 157 | 0.7 | 22  | 654 | 1.38%| 460 | 130 | –   | –   |
| P22    | <0.2| 13.8| 1   | 140 | 2.3 | 22  | 512 | 1.19%| 404 | 110 | –   | –   |
| P23    | –   | 1.3 | 177 | 3   | 18.5| 936 | 2.65%| 560 | 150 | –   | –   | –   |
| P24    | 4   | 35.4| 49  | 163 | –   | 839 | 380 | 1500| 180 | 4   | –   | –   |
| P25    | 1.6 | 8.2 | 5   | 58  | 11  | 485 | 150 | 130 | 1.91%| 1500| 1   | –   |
| P26    | 7   | –   | 41  | 636 | 3.1 | 210 | 85  | –   | 20  | 1   | –   | –   |
| P27    | 0.1 | –   | 5   | 24  | –   | 39  | 90  | –   | 20  | 1   | –   | –   |
| P28    | 2   | –   | 17  | 210 | –   | 100 | 180 | –   | 10  | 2   | –   | –   |
| P29    | 5.8 | –   | 1   | 448 | –   | 190 | 117 | 60  | –   | 2   | –   | –   |
| P30    | 14  | <10 | 4   | 96  | 3.3 | 34  | 120 | –   | 10  | 3   | –   | –   |
| Sample | Au | As | Sb | Se | Hg | Cr | Ag | Ni | Fe | Zn | Co | Sn |
|--------|----|----|----|----|----|----|----|----|----|----|----|----|
| P31    |    |    | 39 | 774 | 0.9 |    | 120 | 50 |    | 12 | 2  |    |
| P32    |    |    | 1990 | 910 | 90  |    | 870 | 890 |    | 20 |    | 9.57% |
| P33    |    |    | 13 | 235 | 6.3 | 240 | 354 | 185 |    | <20 | 6  |    |
| P34    | 2.2 | 7  | 52 | 143 | 0.7 |    | 500 | 160 |    | 20 |    |    |
| P35    | 92 | 1025 | 880 | 130 | <10 | 4220 | 765 | 360 |    | 1.84% | 3.08% | 34 | 2.5% |
| P36    |    |    | 35 | 100 | 0.7 | <23 | 79  | 60  |    | 10 |    |    |
| P37    |    | 4150 | 750 | 1740 | 8  | <160 | 580 |    | 1.27% | 744 | 4  |    |
| P38    | 4  | 1.25% | 45 | 890 | 3  | <70 | 115 | 110 |    |    |    |    |
| P39    | 64 | <10 | 4  | 6   |    | 170 | 27  | 74  | 9040 | 491 | 4  | 260 |
| P40    | 318 | <20 | 1  | 29  | 3  | 190 | 33  | 100 |    | 1.15% | 643 | 4  | 340 |
| P41    | 71 | 5320 | 507 | 315 | 9.7 |    | 1115 | 2510 |    | 1.69% | 947 | 13 | 3.43% |
| P42    | <10 |    | 0.9 |    | <3 | 275 | 5   | 100 |    | 1.55% | 880 | 5  |    |
| P43    | <13 | 80  | 32 | 120 | 3  | 715 | 75  | 690 |    | 4.396% | 2410 | 10 | 1240 |
| P44    |    | 3590 | 2890 | 130 |    |    | 94  | 5690 |    |    | 80 |    | 28.5% |
| P45    | <40 | 290 | 68 | 125 | 16 | 860 | 480 | 550 |    | 2.89% | 1846 | 20 | 2.52% |
| P46    |    | <5  | 3.5 | 24  | 0.2 |    | 15  | 160 |    |    | 10 |    | 2  | 260 |
| P47    | <50 | 820 | 100 | 300 | 30 |    | 5100 | 430 |    | <100 traces |    |    |
| P48    |    | 20  | 2.8 | 3   |    |    | 8   | 170 |    | traces | 2  |    |
| P49    | 0.3 | <5  | 0.3 | 1040 | 0.7 | 352 | 19  | 440 | <200 | 10 |    | 5  |
| P50    | 1.2 | 13  | 7.5 | 10  | <2 |    | 23  | 230 | <200 | 75  | 2  | 460 |
| P51    | 1  | 13  | 2  | 265 | 2.4 |    | 32  | 270 |    |    | 40 |    | 12 |
| P52    | 99 | 3485 | 830 | 2910 |    |    | 1590 |    |    |    |    | 1  |
| P53    | 36 | 52  | 853 | 160 | 9.4 |    | 3250 | 390 |    |    |    | 1  |
| P54    | 12.5 | 4350 | 8517 |    |    |    | 42  | 3140 | 9970 | 490 |    | 70 | 23.8% |
| P55    | 32.5 | 1900 | 430 | 110 |    |    | 524 | 780 |    | 5.9% | 20 |    | 7.56% |
| P56    | 25 | 170 | 32 | 4710 |    |    | 1200 | 2239 | 549 | 6.92% | 4086 | 16 |    |
| P57    | 23 | <19 | 10.3 | 334 | 2  |    | 1544 | 340 |    |    | 40 |    | 1  |
| P58    | 21 | 7150 | 1.22% |    |    |    | 3900 | 5327 |    |    | 30 |    | 7.07% |
| P59    | 2 | 78  | 76 |    |    |    | 1410 | 20 | <470 | 5.79% | 4% | 14 |    |
| P60    | 15 |    | 5  | 190 |    | <100 | 832 | 135 | 4220 | 250 |    | 2  |
| P61    | 17.5 | 4370 | 2440 | 40 |    |    | 250 | 5170 |    |    | 220 |    | 28.02% |
| P62    | 9 | 1100 | 1044 | 80 | <7 |    | 600 | 1690 |    |    | 50 |    | 81 | 21.82% |
| P63    | 28.1 | 297 | 490 | 140 |    |    | 1320 | 1220 |    |    | 1  | 500 |
| P64    | 0.6 | 20 | 16 | 8 | <3 |    | 73  | 120 |    | 23 |    |    | 2  |
| Sample | Au   | As | Sb | Se | Hg | Cr | Ag | Ni | Fe | Zn | Co | Sn |
|--------|------|----|----|----|----|----|----|----|----|----|----|----|
| P65    | 150  | –  | 6  | 60 | 17 | 500| 45 | 224| 1.65%| 1270| 5  | –  |
| P66    | <0.6 | –  | 1  | 20 | <4 | –  | 20 | 90 | –  | 10  | 1  | –  |
| P67    | 2    | –  | 2  | 30 | 8  | 345| 9  | <100| 2.04%| 1160| 6  | –  |
| P68    | <0.2 | 10 | 3  | 38 | 1  | 128| 5  | 65 | 6080| 350 | 5  | –  |
| P69    | 11.2 | 12 | 23 | 495| 3.2| –  | 542| 215| –  | –   | 1  | –  |
| P70    | 8.8  | <7 | 3  | 45 | 0.8| 620| 21 | 180| 7640| 596 | 5  | –  |
| P71    | 8.5  | <5 | 1.5| 350| –  | 130| 210| 115| 7440| 387 | 7  | –  |
| P72    | traces| 5  | 1  | 518| 0.4| –  | 19 | 275| –  | 7   | 4  | –  |
| P73    | 1.6  | 660| 137| 310| 5.2| <40| 110| 810| 5100| 340 | 40 | 2.89%|
| P74    | 5    | <5 | 12 | 178| 4  | 77 | 247| 170| 4100| 230 | 2  | –  |
| P75    | 3.9  | –  | 3  | 190| 5  | –  | 355| 220| –   | –   | 1  | –  |
| P76    | 25   | –  | 125| 590| 255| –  | 463| 180| –   | –   | 1  | –  |
| P77    | 5.5  | <5 | 1.5| 107| 0.6| –  | 11 | 150| –   | 6   | 1  | –  |
| P78    | 1.6  | <6 | 7  | 42 | –  | <40| 25 | 230| <200| 17  | 2  | –  |
| P79    | 38.7 | 1420| 357| 85 | 3.3| –  | 310| 3950| 5080| 310 | 75 | 27.83%|
| P80    | 11.2 | 8  | 32 | 87 | 5  | 150| 230| 245| 7650| 456 | 4  | 920 |
| P81    | 13.2 | –  | 31 | 7.37%| –  | <100| 459| 118| 3400| 190 | 2  | –  |
| P82    | <0.2 | 13 | 5  | 804| 1.3| 72 | 10 | 201| 2720| 154 | 2  | 110 |
| P83    | 1.1  | <4 | 8  | 37 | 0.8| 80 | 75 | 116| 2840| 143 | 2  | –  |
| P84    | 0.2  | 6  | 2  | 3  | <4 | 70 | 15 | 80 | –   | 16  | 3  | –  |
| P85    | 4.7  | 250| 676| 210| 16 | –  | 340| –  | 4140| 1.18%| 4  | 57.91%|
| P86    | –    | 46 | 4  | 10 | <2 | 177| 12 | 40 | 5850| 460 | 7  | –  |
| P87    | 0.4  | –  | 4  | 18 | –  | 70 | 18 | 150| 3750| 227 | 2  | –  |
| P88    | 0.7  | 15 | 5  | 6  | <1 | 30 | 21 | 170| 2610| 130 | 2  | –  |
| P89    | 1.8  | 27 | 1160| 40 | –  | –  | 74 | 340| 4800| 250 | 2  | –  |
| P90    | 83   | 8240| 17 | 478| 0.54| 215| 265| 210| 1.025%| 580 | 4  | –  |
| P91    | 7.7  | 1600| 320| 425| 0.03| 200| 210| 440| 1%  | 520 | 2  | –  |
| P92    | 0.7  | 3  | 1  | 4  | 1.8| 20 | 5  | 162| 1550| 55  | 2  | –  |
| P93    | 1.1  | <3 | 1  | 3  | 2  | 30 | 5  | 160| 1500| 50  | 2  | –  |

- = under the limit of det.