中华人民共和国土壤环境背景值图集

THE ATLAS OF SOIL ENVIRONMENTAL BACKGROUND VALUE IN THE PEOPLE'S REPUBLIC OF CHINA

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前　言

(一)

土壤环境背景值是指土壤在发育形成过程中，未受或很少受到人为活动的影响，特别是未受或很少受到污染、破坏的情况下，土壤本身固有的化学组成和含量。它基本反映土壤环境原有的物质组成、性质和结构特征。

编制土壤环境背景值图是土壤环境背景值研究的深化，它将土壤环境背景值的研究成果，以专题地图的形式表现出来，使之成为直观、形象的图面资料，能定性、定量、定位地反映土壤中不同元素背景含量在空间的分布特征，反映区域分异规律及与制约因素之间的内在联系，并准确地揭示出土壤环境背景值异常区的位置，为进一步研究异常区的成因奠定了良好基础。

《中华人民共和国土壤环境背景值图集》的编辑与出版，将为我国环境保护事业的发展和环境科学的基础研究提供科学依据；为防治地方环境疾病和掌握土壤微量元素含量、分布提供可靠依据；对地质科学研究和地球化学找矿有极大的参考价值；为高等院校和科研单位开展有关教学与科研工作提供重要基础资料；也为我国地图科学和环境制图的发展积累更丰富的经验。它标志着我国在土壤环境背景值的研究领域中已跨入了世界先进行列。

(二)

《中华人民共和国土壤环境背景值图集》的编制，是“七五”国家科技重点攻关项目《全国土壤环境背景值研究》的子专题，是攻关项目规定必须达到的目标之一。项目的主持部门是国家环境保护局，参与主持部门是国家教育委员会和中国科学院。承担专题的组长单位是中国环境监测总站，副组长单位是北京大学和中国科学院沈阳应用生态研究所。本图集由中国环境监测总站主编，副主编单位有东北师范大学、中国科学院成都山地灾害与环境研究所和成都市环境保护科学研究所。北京大学参加了部分基础图件的编绘工作。各省、市、自治区及大连、温州、厦门、深圳等城市的环境保护监测站、环保科学研究所等单位，中国科学院的有关研究所，国家教育委员会的有关大专院校等国内数十个单位，参加了全国土壤环境背景值的研究工作，为本图集的编制提供了大量的基础数据和图件资料。我国制图学、土壤学、环境学界的老专家陈述彭、张力果、陈静生、廖克、陈昱、魏复盛、吴燕玉等先生应邀作为图集编制的顾问，自始至终为图集的编辑出版给予了亲切的指导。该图集的编辑出版是集体智慧的结晶，是我国自“六五”开展土壤环境背景值研究以来的10年期间，100余个单位协作攻关，1000余名同行、专家共同努力、艰苦奋斗的劳动成果。

(三)

图集由4个图组构成，共187幅图，分为序图组(6幅)、单元素环境背景值图组(133幅)、多元素环境背景值图组(28)幅和实验图组(20幅)。序图组主要反映土壤环境背景值的主要影响因素，如土壤类型、土壤母质母岩、土壤pH值、土壤有机质含量、土壤质地等因素的分布状况。便于读者在深入探讨土壤微量元素的地域分异规律时参考。同时将采样点分布图列入序图组中，并加注了各省、市、自治区的统一编号，和《中国土壤元素背景值》相一致，便于大家在使用时核对各点位的元素含量。单元素环境背景值图组中共收集了三种类型的图件。第一种类型是重点研究的13个元素的分区分级统计图，有铜(Cu)、铅(Pb)、锌(Zn)、镉(Cd)、镍(Ni)、铬(Cr)、汞(Hg)、砷(As)、氟(F)、锰(Mn)、钴(Co)、钒(V)、硒(Se)，此种类型的图以手工编图为主，编绘时首先由计算机按元素分别进行了影响因素分析，然后根据影响因素的顺序，按着含量等级综合，绘制等级界线成图，以充分发挥专家智能的作用。第二种类型是计算机绘制的分级点位符号图，全面反映61个化学元素在土壤A层的含量分布状况，用定位分级符号表现出来。第三种类型是插值格网图，在分级点位图的基础上，以克里格(Kriging)法进行插值，由计算机来完成，筛选出59个化学元素的格网图，同时列出了每个元素插值的数学模型与效果检验参数，供大家在使用时参考。多元素环境背景值图组包括15组综合分级点位图和13组综合插值格网图。将61个化学元素在逐级进行相关显著性聚类分析的基础上，经筛选把环境地球化学性质相近，数据相关性较好的元素划分为一组，对组内数据进行标准化处理后将系数加和，按顺序统计量分级由计算机绘制而成。其目的在于对土壤中各元素的环境地球化学区划作初步探索，以求为土壤环境背景值的后续研究指出方向。实验图组主要包括彩色分级立体透视图、彩色分级立体透视剖面图和等值线图，以探索计算机绘图的多种表现形式，使读者对部分元素背景含量在全国的分布特征有更直观、醒目的感性认识。由于该图组属实验性质，只选择了部分元素和影响因素成图。

本图集采用了以机助制图为主，机助制图与常规制图相结合的原则，并用多种表现方法和绘图方法，便于读者相互比较，取长补短，各取所需，相得益彰。制图所用的全部数据资料均经过严格的质量审查。从布点设计、采样、样品处理、化验分析、数据处理，直至图件编绘，都是在全程序的质量保证和质量控制下进行的，因而是可信的，编图数据均采用按顺序统计量统一分级，与《中国土壤元素背景值》数据册相对应，两套资料可对照使用。

(四)

《中华人民共和国土壤环境背景值图集》在我国属首次编辑出版，在世界也属罕见。由于第一次编制61个元素的大型全国土壤环境背景值图集，既具有创新性和开拓性，也具有探索性和冒险性。我们认为，在我们这个贫穷而落后的东方古国，在开展“四化”建设的伟大事业中，没有一点开拓进取和敢于冒险的精神，是任何事情也不可能成功的。正是在这种精神的鼓舞下，激励我们不辞辛劳，不惜流汗，在有限的财力物力条件下，日夜兼程，以最快的速度，完成了规模浩大的图集攻关任务。今天，我们将这本图集奉献给我们伟大的祖国和可爱的人民，表达了我国环保工作者的赤诚之心，愿为我国环境保护事业的发展贡献绵帛之力，如果它能为祖国“四化”大业和环保事业的发展起到一点作用，那将是我们极大的欣慰。

由于是探索性的工作，加之我们的业务水平有限，图集中不当和不足之处在所难免，恳请国内、外同行、专家不吝赐教，我们愿意认真听取大家的意见，以便再版时进一步修改、补充，使之更加完善。

在图集的编制、研究过程中，曾得到了美国地质调查局H．T．Sacklette博士、R．R．Tidball博士、L．L．Jackson博士、邱成财博士、赵畯田博士、J．A．Erdman博士、乔治亚大学萨瓦拉河生态系统研究所D．C．Adriado博士、美国国家环保局吴捷博士等多方支持。重庆大学信息制图研究所、成都地图出版社印刷厂等单位对图集的绘制印刷工作给予了大力支持和协助。在此，编委会向一切给予本图集研究、编辑、出版、印刷工作以热情关怀，大力支持的人士，表示衷心的感谢！

《中华人民共和国土壤环境背景值图集》编委会

FOREWORD

Ⅰ

Soil environmental background value(abbr. SEBV) means the intrinsic chemical composition and contents of the soil itself which has not been or very little affected by the human activities, especially under the circumstances of being not polluted or not ruined in the process of the development and formation of the soil, It reflects fundamentally the characteristic of the intrinsic material composition properties and structure of the soil.

To compile the atlas of-SEBV is to deepen the research work of SE BV. It shows the achievements in scientific research as a form of the thematic map, so as to become an aduio-visual and imaged drawing material which can reflect qualitatively, and quantitatively, and also in orientation, the spacial distribution characteristic of the different element background content in soil. In addition, it reflects Law of Regional Differentiation and the internal relations between the differentiation factors, and it also reveals exactly the position of abnormal from SEBV, and thus to establish a good foundation for further investigating the cause of the formation of abnormal regions.

The compilation and publication of the Atlas of Soil Environmental Background Value in the P. R. China(abbr. ASEBV) will show profound significace as follows: (1) It will provide scientific foundation for both the development of the great task of environmental protection of our country and the rigorous work of basic research or environmental science; (2) It will provide reliable basic for both prevention and treatment of local environmental disease and grasp of soil trail element content and distribution which possess important reference value for geological prospecting and geochemistry information of mineral resources; and (3) It would provide by itself as an important material for institutions of higher learning, and also for scientific research units to carry out the concerned teaching and scientific research work, and, at the same time, it would promote the development and enrich further experience by itself for the map science and environmental mapmaking work in our country. Thus, the present atlas marks that our country in the research field of SEBV has stepped into the advanced rank of the world.

Ⅱ

The work of compiling SEBV is a subtitle of the emphasized research projects of tackling key problem, the Study of National SEBV, during the Seventh Five-Year plan in our country, and it is assigned one of the targets which should be achieved. The responsible department of the project is National Environmental Protection Agency of the People's Republic of China, and participating responsible department is China National Education Committee and Chinese Academy of Sciences. The leader unit is China National Environmental Monitoring Centre(abbr. CNEMC); the associate leader units are Beijing University and Shenyang Applied Ecology Research Institute of Chinese Academy of Sciences. The chief editor unit of the present atlas is CNEMC; the associate chief editor units are Northeast Normal University, Chengdu Institute of Mountain Disasters & Environment, Chinese Academy of Sciences, and Chengdu Municipal En vironmental Protection Research Institute. Beijing University took part in co mpiling and drawing some of the fundamental graphs. There were about several ten units, such as environmental protection monitoring stations, and scientific institutes of each province, city, autonomous region; and citites of Dalian, Wenzhou, Xiamen, and Shenzhen, etc.; the comcerned institute of Chinese Academy of Sciences and the concerned University or College of National Education Committee to take part in the work of SEBV throughout China; so that a large amount of fundamental data and graph material were provided for composition of the present atlas. Elder specialists of our country in the field of map-makimg, soil science, and environmental science. such as Mr. Chen Shupeng, Mr. Zhang Liguo, Mr. Chen Jingsheng, Mr. Liao Ke, Mr. Chen Yu, Mr. Wei Fusheng, and Ms Wu Yanyu, et al. have been invited as compiling advisers, They directed the composition and publication of the present atlas cordially from the beginning to the end. Therefore, the present atlas could be regarded as a crystallization of collective wisdom. It is really the fruit of labour by tremendous efforts of over a hundred coordinate units for tackle key problem, and over a thousand colleagues and experts to pay great attention to the study of SEBV during nearly ten years, since the start of Sixth Five-Year plan.

Ⅲ

The atlas 187 maps in all, is composed of four map-groups. It is the preliminary map-group (6 maps), the mono-element background value map-group(133 maps), the multi-element background value map-group (28 maps), and the experimental map-group(20 maps). The preliminary map-group reflects mainly the distribution characteristics of influencing factors of SEBV, such as soil type, soil mother material and mother rock, soil pH value, soil organic matter content, and soil texture, etc.. It is convenient for the readers to make reference while they go further into the law of Regional Differentiation about the soil trace elements, and at the same time, the map of sampling sites is also put into the preliminary map-group, and in addition, there are attached notes of unified serial numbers of each province, city, and autonomous region, which are in agreement with the data manual, "China SEBV", so that it is convenient for the readers to check each site of the element content. The mono-element baok-ground value map-group collects 3 types of maps. The first type is regionalized-and graded-statistic map of 13 elements, i. e. Cu, Pb, Zn, Cd, Ni, Cr, Hg, As, F, Mn, Co, V and Se, which are emphasized in the investigation. This type of map is compiled and drawn mainly by hand. In doing so, the first thing is to use computer to analyse the influencing factors of the elements respectively. Then based upon the sequence of major influencing factors of each element, we worked out the synthesis with the graded content, and drew graphs of the grades boundary, so as to give full play to specialists, knowledge and skill. The second type is a graded point sites map, which was formed mainly by computer. It reflects all-sidely content distribution in layer A of the soil of the 61 chemical elements shown by the graded symbols of locations. The third type is an interpolating grid map. It was based upon graded point sites map to carry out interpolation by means of Kriging by computer. Thus graphs of 59 chemical elements

were screened. Meanwhile, the mathematical model of interpolation and effectiveness-examination parameters of each element are listed to provide reference for the reader's utilization. The multi-element background value map-group includes 15 synthetical graded point sites maps and 13 synthetical interpolating grid maps. Based upon the cluster analysis of correlation significance of 61 elements grade by grade. It can be grouped by screening that the elements possess similar environmental geochemical properties and the better correlation, and then standardized the data within each group, and then summed up the conefficients grade statistically in sequence at last drew. The maps by computer respectively purpose of such cartography lies in the preliminary exploration for environmental geochemical regionalization of each element in soil, and thereby to point out the direction of successive study on SEBV. Experimental group includes mainly perspective map, perspective profile map and isopleth map of which the purpose is to explore the various forms of display of computer mapping, so that the readers can obtain more audio-visual and more attractive perceptual knowledge of the distribution characteristic of SEBV from a part of elements distributed throughout China. The map group is limited to the selection of only some elements and influencing factors, owing to the fact that this graph is still at the experimental stage.

The present Atlas applied a principle of taking the computer drawing as a major means and combining the computer drawing with the conventional drawing and at the same time various methods of display and drawing were used, so that the readers can judge from the comparison between one method and another, take advantage of one drawing to offset others' weakness, take what he needs or the methods themselves may be able to supplement each other. All the data and informations used in compiling and drawing have passed strict quality review. The design of distribution of point sites, sample treatment, examination and analysis, data processing, untill compiling and drawing the map, are all conducted, under the quality control and quality assurance through the whole process. Therefore, the present Atlas is reliable. The data applied in the map compiling were all graded according to the sequential statistic value and corresponded to those of the data manual of " China SEBV". Thus, the both Books can be refered to each other.

Ⅳ

It is for the first time to compile and publish" ASEBV" in China, and it is also seldom to see such a work in the world. Owing to the first time to compile such a large atlas, including 61 chemical elements, it has not only the properties of blazing new trails and exploitation, but also the properties of exploration and adventures. However, we believed that without any enterprising. and adventurous spirit, there would be no possibilities of success on anything while we were carring out the great task of Four Modernization for such an oriental ancient nation in which poor and less developed were not resolved as yet. Since under encouragement of the above spirit, we were excited to make nothing of hardships, and spareed no paints in a sweat, and under the conditions of limited financial and material resouces, we worked night to day with the most rapid speed to accomplish the broad scale job of tackle key problem of the atlas, Now, we offer the present atlas to our motherland and the beloved people to express our ulter devotion, and we are willing to make any sacrifice with our meager strength. If the present atlas is somewhat useful to the great task of the Four Modernization of our country and to the development of the environmental undertaking, it will be very gratified to us.

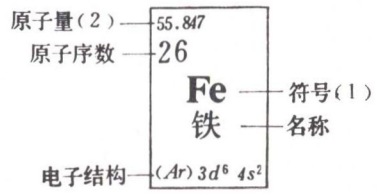
Since it was an exploratory work, and at the same time we were limited by our professional skill, mistakes and inadequacy in the atlas have been hard to avoid. We whole hearted hope that internal and external persons of the same trade or experts will not stint to give criticism, we are ready to hear the opinions in order to make further revision and supplement in second edition, so as to make the Atlas more perfect.

In the compiling and studing of the atlas, we have the honour of many-sided acquiring support offered by Dr. H. T. Shacklette, Dr. R. R. Tidball, Dr. L. L. Jackson, Dr, Cary T. Chiou, Dr. T. T. Zhao, Dr. J. A. Erdman, USGS, D. C. Adriano, Savannah River Ecology Laboratory, University of Georgia, Mr. Chieh Wu, Environmental Protection Agence of U. S. A. during the printing and publishing, we acquired a great support and assistance from the institutions such as Chongqing University Information Cartography Institute. Chengdu Map Publisher printing Factory, etc.. Here, we express heartfelt thanks to all the units which concerned and supported the compiling and publishing work of the atlas.

The Editorial Department of"**ASEBV**"

本专题研究的化学元素在化学元素周期表中的位置

The location of chemical elements investigated in the periodic table of chemical elements



周期 \ 族	I A	II A	III B	IV B	V B	VI B	VII B	VIII B			I B	II B	III A	IV A	V A	VI A	VII A	VIII A
1	1.0079 1 氢 H $1s^1$																H	4.00260 2 氦 He $1s^2$
2	6.941 3 锂 Li $1s^2\ 2s^1$	9.01218 4 铍 Be $1s^2\ 2s^2$											10.81 5 硼 B $1s^2\ 2s^2\ 2p^1$	12.011 6 碳 C $1s^2\ 2s^2\ 2p^2$	14.0067 7 氮 N $1s^2\ 2s^2\ 2p^3$	15.9994 8 氧 O $1s^2\ 2s^2\ 2p^4$	18.998403 9 氟 F $1s^2\ 2s^2\ 2p^5$	20.179 10 氖 Ne $1s^2\ 2s^2\ 2p^6$
3	22.98977 11 钠 Na (Ne) $3s^1$	24.305 12 镁 Mg (Ne) $3s^2$											26.98154 13 铝 Al (Ne) $3s^2\ 3p^1$	28.0855 14 硅 Si (Ne) $3s^2\ 3p^2$	30.97376 15 磷 P (Ne) $3s^2\ 3p^3$	32.06 16 硫 S (Ne) $3s^2\ 3p^4$	35.453 17 氯 Cl (Ne) $3s^2\ 3p^5$	39.948 18 氩 Ar (Ne) $3s^2\ 3p^6$
4	39.0983 19 钾 K (Ar) $4s^1$	40.08 20 钙 Ca (Ar) $4s^2$	44.9559 21 钪 Sc (Ar) $3d^1\ 4s^2$	47.90 22 钛 Ti (Ar) $3d^2\ 4s^2$	50.9414 23 钒 V (Ar) $3d^3\ 4s^2$	51.996 24 铬 Cr (Ar) $3d^5\ 4s^1$	54.9380 25 锰 Mn (Ar) $3d^5\ 4s^2$	55.847 26 铁 Fe (Ar) $3d^6\ 4s^2$	58.9332 27 钴 Co (Ar) $3d^7\ 4s^2$	58.70 28 镍 Ni (Ar) $3d^8\ 4s^2$	63.546 29 铜 Cu (Ar) $3d^{10}\ 4s^1$	65.38 30 锌 Zn (Ar) $3d^{10}4s^2$	69.72 31 镓 Ga (Zn) $4p^1$	72.59 32 锗 Ge (Zn) $4p^2$	74.9216 33 砷 As (Zn) $4p^3$	78.96 34 硒 Se (Zn) $4p^4$	79.904 35 溴 Br (Zn) $4p^5$	83.80 36 氪 Kr (Zn) $4p^6$
5	85.4678 37 铷 Rb (Kr) $5s^1$	87.62 38 锶 Sr (Kr) $5s^2$	88.9059 39 钇 Y (Kr) $4d^1\ 5s^1$	91.22 40 锆 Zr (Kr) $4d^2\ 5s^2$	92.9064 41 铌 Nb (Kr) $4d^4\ 5s^1$	95.94 42 钼 Mo (Kr) $4d^5\ 5s^1$	98.9082 43 锝 Tc (Kr) $4d^6\ 5s^1$	101.07 44 钌 Ru (Kr) $4d^7\ 5s^1$	102.9055 45 铑 Rh (Kr) $4d^8\ 5s^1$	106.4 46 钯 Pd (Kr) $4d^{10}\ 5s^0$	107.868 47 银 Ag (Kr) $4d^{10}\ 5s^1$	112.41 48 镉 Cd (Kr) $4d^{10}\ 5s^2$	114.82 49 铟 In (Cd) $5p^1$	118.69 50 锡 Sn (Cd) $5p^2$	121.75 51 锑 Sb (Cd) $5p^3$	127.60 52 碲 Te (Cd) $5p^4$	126.9045 53 碘 I (Cd) $5p^5$	131.30 54 氙 Xe (Cd) $5p^6$
6	132.9054 55 铯 Cs (Xe) $6s^1$	137.33 56 钡 Ba (Xe) $6s^2$	138.9055 57 ▲ 镧 La (Xe) $5d^1\ 6s^2$	178.49 72 铪 Hf (Xe) $4f^{14}\ 5d^2\ 6s^2$	180.9479 73 钽 Ta (Xe) $4f^{14}\ 5d^3\ 6s^2$	183.85 74 钨 W (Xe) $4f^{14}\ 5d^4\ 6s^2$	186.207 75 铼 Re (Xe) $4f^{14}\ 5d^5\ 6s^2$	190.2 76 锇 Os (Xe) $4f^{14}\ 5d^6\ 6s^2$	192.22 77 铱 Ir (Xe) $4f^{14}\ 5d^7\ 6s^2$	195.09 78 铂 Pt (Xe) $4f^{14}\ 5d^9\ 6s^1$	196.9665 79 金 Au (Xe) $4f^{14}\ 5d^{10}6s^1$	200.59 80 汞 Hg (Xe) $4f^{14}\ 5d^{10}\ 6s^2$	204.37 81 铊 Tl (Hg) $6p^1$	207.2 82 铅 Pb (Hg) $6p^2$	208.9804 83 铋 Bi (Hg) $6p^3$	(210) 84 钋 Po (Hg) $6p^4$	(210) 85 砹 At (Hg) $6p^5$	(222) 86 氡 Rn (Hg) $6p^6$
7	(223) 87 钫 Fr (Rn) $7s^1$	226.0254 88 镭 Ra (Rn) $7s^2$	(227) 89 △ 锕 Ac (Rn) $6d^1\ 7s^2$	(272) 104 Rf (Ku) (Rn) $5f^{14}\ 6d^2\ 7s^2$	105 Ha (Rn) $5f^{14}\ 6d^3 7s^2$	106 (Rn)												

[注] (1)黑——固体; 红——气体; 蓝——液体; 斜网线字——自然界未发现的人造元素。

(2)以C-12为基准,( )表示最稳定的或了解最清楚的同位素。

专题研究的化学元素
The chemical elements in the special investigation

专题重点研究的化学元素
The key chemical elements in the special investigation

▲	140.12 58 铈 Ce (Xe) $4f^2\ 5d^0\ 6s^2$	140.9077 59 镨 Pr (Xe) $4f^3\ 5d^0\ 6s^2$	144.24 60 钕 Nd (Xe) $4f^4\ 5d^0\ 6s^2$	(147) 61 钷 Pm (Xe) $4f^5\ 5d^0\ 6s^2$	150.4 62 钐 Sm (Xe) $4f^6\ 5d^0\ 6s^2$	151.96 63 铕 Eu (Xe) $4f^7\ 5d^0\ 6s^2$	157.25 64 钆 Gd (Xe) $4f^7\ 5d^1\ 6s^2$	158.9254 65 铽 Tb (Xe) $4f^9\ 5d^0\ 6s^2$	162.50 66 镝 Dy (Xe) $4f^{10}\ 5d^0\ 6s^2$	164.9304 67 钬 Ho (Xe) $4f^{11}\ 5d^0\ 6s^2$	167.26 68 铒 Er (Xe) $4f^{12}\ 5d^0\ 6s^2$	168.9342 69 铥 Tm (Xe) $4f^{13}\ 5d^0\ 6s^2$	173.04 70 镱 Yb (Xe) $4f^{14}\ 5d^0\ 6s^2$	174.97 71 镥 Lu (Xe) $4f^{14}\ 5d^1\ 6s^2$
△	232.0381 90 钍 Th (Rn) $5f^0\ 6d^2\ 7s^2$	231.0359 91 镤 Pa (Rn) $5f^2\ 6d^1\ 7s^2$	238.029 92 铀 U (Rn) $5f^3\ 6d^1\ 7s^2$	237.0482 93 镎 Np (Rn) $5f^4\ 6d^1\ 7s^2$	(242) 94 钚 Pu (Rn) $5f^6\ 6d^0\ 7s^2$	(243) 95 镅 Am (Rn) $5f^7\ 6d^0\ 7s^2$	(247) 96 锔 Cm (Rn) $5f^7\ 6d^1\ 7s^2$	(247) 97 锫 Bk (Rn) $5f^9\ 6d^0\ 7s^2$	(249) 98 锎 Cf (Rn) $5f^{10}\ 6d^0\ 7s^2$	(254) 99 锿 Es (Rn) $5f^{11}\ 6d^0\ 7s^2$	(253) 100 镄 Fm (Rn) $5f^{12}\ 6d^0\ 7s^2$	(256) 101 钔 Md (Rn) $5f^{13}\ 6d^0\ 7s^2$	(254) 102 锘 No (Rn) $5f^{14}\ 6d^0\ 7s^2$	(257) 103 铹 Lr (Rn) $5f^{14}\ 6d^1\ 7s^2$

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