Opening Article

Element strategy: scientific research backed by a world and historical view

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Japan's "Element strategy" Initiative is being implemented under the supervision of the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry. This Initiative is composed of four tactical research issues: "reduce quantity," "replace," "recycle," and "regulate." Here I would like to use this element strategy as an example to consider whether the implementation of this type of policy will merely overcome technological hurdles or whether it could actually lead to the establishment of a new way of viewing the world—that is, a new research philosophy for natural science that blazes a new trail in philosophy.

Chemists from the 1960s to the 1980s were hunters roaming the untouched wilderness of the periodic table searching for treasure troves. For instance, this "element hunting" was largely responsible for the development of catalysis chemistry. Japanese at the time were at the forefront of this research, with Japanese chemists Ryoji Noyori, Eiichi Negishi, Akira Suzuki, and others fully capitalizing on the characteristics of elements and being honored the Nobel Prize. Looking back from today, we can recognize that the reductionist proposition of "elucidating the secrets of the elements" since the 19th century was what underpinned this period of "element hunting."

Now, as we are exhaustively exploring the properties of many elements, there needs to be something in the worldview that supports chemistry in the 21st century that goes a step beyond "elucidating the secrets of the elements," which might be "Alchemia Nova" or something else. It is the Element Strategy that supports the said something as a policy. Almost everything that is called a strategy inevitably requires a philosophy. In other words, there needs to be a justification for why Japan is undertaking the strategy. Although the fact that imports of rare earth metals seem likely to be halted explains the setting of a policy issue and a technological agenda in a narrow sense, it cannot be the philosophy of scientists, let alone that of the country. Some people may be interested in "cooperative action on multiple elements," but this is a tactical issue, not a philosophy. The policy being hammered out by the government requires a firm backing in the form of a worldview. Scientific research is being incorporated into the recent trumpeting of national strategy. As each scientist polishes up his or her own view of history and of the world, their participation then will give rise to a Japanese national strategy that can be the pride of the world.

What I am suggesting here is that the supporting philosophy for the Element Strategy lies in the history of humankind itself. The history of humankind is the history of conflict. Such conflict led to bloodshed, but it also was a source of progress. If humans had innately been adverse to conflict and if they had remained in Africa, Caesar in Rome, Oda Nobunaga in Nagoya, and chosen a leisurely existence, then how would our history have turned out? There would certainly not have been any cultural exchange, nor any science or technology. The major factors in conflict are ethnic groups, religions, and resources. Natural scientists cannot directly contribute to the resolution of the first two factors, but they can directly contribute to the resolution of conflicts over resources by competition. Not only that, they can also contribute to the construction of frameworks for international cooperation that utilize each country's strengths and weaknesses. I believe the message that Japan's Element Strategy should send to the world is, "Let's mobilize the power of researchers to create a new society.[1)]"

In his book *An Essay on the Principle of Population* (1798), Thomas Malthus discussed the correlation between population and the increase and decrease of life resources and its outcome, and stated in conclusion, "Evil exists in the world not to create despair but activity." If a paucity of elements is to become a source of conflict, science will proceed through the efforts of scientists to prevent such conflict. The words of Malthus ring just as true in the 21st century.

1) "Managing the Scarcity of Chemical Elements", E. Nakamura, K. Sato, *Nat. Mater.* **2011**, *10*, 158.

The *Kagaku to Kogyo* (Chemistry & Chemical Industry) Editorial is responsible for the English-translated article.