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October 30, 1944

To: Memo

From: W. E. Cohn

1. C. D. Coryell
2. R. S. Stone
3. H. J. Curtis
4. K. S. Cole
5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, &
17. R. L. Doan
18. S. K. Allison
19, 20, 21, 22, &
23. W. E. Cohn
24. Central File
25. Reading File

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DATE JUL 1962
For the Atomic Energy Commission
Chief, Declassification Branch

In a letter to S. K. Allison, dated January 27, 1944, I surveyed the uses of radioactive isotopes in biology and medicine, listed the isotopes likely to be most useful (based on present knowledge), and pointed out the advantages of pile production in overcoming some of the major difficulties that have arisen in the past. Present interest in and discussion of the post-war applications of the pile and new developments in this tool call for the indication of certain phases not covered in this previous letter.

The importance of C^{14} in the elucidation of metabolic processes has been stressed previously. There is no other tracer as suitable for carbon as C^{14}, and no tool offers as much hope in making possible the understanding of the methods by which life is maintained at the expense of solar energy. It has been pointed out that C^{14} offers a means of reducing the empiricism of such industrial processes as petroleum refining and synthetic rubber production; these processes are probably no more complex than the oxidation of carbonaceous compounds by living organisms, and are certainly not as important to the human race as the latter.

Mention of petroleum brings to mind the discussion of the reserves of energy-producing material available to the inhabitants of this world. Coal, petroleum, uranium--all are materials the utilization of which for energy production may not continue indefinitely. The one source of energy which will be available to us for something approaching infinite time and in practically unlimited quantity is the sun. Solar energy is now made available to us on a routine basis through water power and through the synthesis, by plant life, of carbonaceous compounds. The mystery of photosynethesis will some day be unraveled with the aid of C^{14} tracer, which shows so much promise in this field. It is not inconceivable that the clarification of the naturally-occurring photosynthetic mechanisms, coupled with similar understanding of the metabolic utilization of the compounds synthesized (i.e., utilization of the stored energy), could lead either to the ability to reproduce the entire cycle at will, or to the invention of synthetic process for the storage and utilization of solar energy. This is a long-range problem, but one with proportionally long-range results.

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It seems axiomatic that the most complex problems are the most fundamental, and that these in turn are the most difficult to approach. This is certainly true in the carbon field. From the production of C^{14} to the biological results obtained from its use lie many steps, all complex and difficult. Production, isolation, synthesis into organic compounds, administration to biological systems, collection, measurement, and analysis of the data are all difficult steps. Each calls not only for specialists in the field concerned (physics, chemistry, biochemistry, and their subdivisions of engineering, electronics, and enzymology) but also for those who can bridge the gaps between these fields so that each contributes most effectively to the final results. Without individuals conversant in some degree with all the fields involved the efforts of those involved in each step may be very inefficiently utilized.

Efficient C^{14} utilization in biological (or other) fields therefore involves the creation of an institute concerned with the problems of production, synthesis, and measurement, and to some degree familiar with the experimental utilization of the chemical product as the bare minimum (See letter of Curtis to Stone, 8/29/44). It would be advantageous to keep the entire cycle within the frame of one organization; this would insure the maximum yield of information and maximum utilization of material. Such an institute should not be supported by any private concern for at least two reasons: it has no guarantee of turning into a profitable enterprise in its major effort within a few years (although profitable discoveries may be anticipated along lines of minor importance), and its long-range results are of too great importance to the world at large to be the property of any single group. It should be, in a sense, comparable to the Health Service and the Cancer Institue in its conception. The Regional Laboratories already in service are another example of this concept.

In MUC-HG-71 (April 10, 1943), I submitted some figures on the possible yield of C^{14} from ammonium salts piled on the outside of a pile of W size. These indicated that, on a small plant scale, one might make about 1 mg. of C^{14} per day, an amount measurable in 10^5 to 10^6 dilution and permitting of ten to several hundred experiments. By direct exposure in the Clinton pile as a side line this amount can be made by the use of laboratory-scale apparatus. While 1 mg./day would not approach the amount necessary to glut the potential market, it would go a long way toward meeting minimum starting needs and in the devising of the necessary organization.

In the previous letter I made no mention of the fission products themselves in the biological fields. Of those that are known only I and Sr have been of much use as biological tracers or as internally-deposited radioactive therapeutic agents. The remainder known (e.g., Y, Ce, Zr) seem to be unessential, as chemicals, to life processes. This would seem to diminish the prospects of any demand for them as biological tracers or therapeutics. However, possibilities may be envisioned which counter this argument. One need go back only a few years to find the view that such elements as Cu, Mn, Zn, etc., were non-essential to living organisms. Such,

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we now know, is not the case. It is possible that the elements occurring in fission may likewise turn out to have positive biological functions. Furthermore, other species may enter the field as the result of investigations in fast fission, and in the fission of materials other than uranium. The fact that at least Sr and I are definitely in demand even now gives us considerable security in predicting that much biological use may be made of the fission species themselves. Furthermore, the lack of a specific biological function does not mean the lack of specific biological properties, which may wind up in a specific medical or other practical use. The metabolism of Y, or its compounds, as uncovered by tracer investigation, may, for example, make possible its use on a therapeutic scale.

Nor should the use of fission products as non-specific sources of radiation or non-specific tracers (biological, chemical, or industrial) be overlooked. In certain processes, for example, the only need may be for a soluble, beta-emitting, carrier-free source of curie strength. Many fission products could qualify for such a use. And the use of a fission product purely as a source of radiation is not dependent upon its chemical nature, but only upon the properties of its radiation. The need for fission species in the project has led to the development of methods for the isolation of pure species in large amounts, as regards activity, without the use of carriers. The use of such material as point sources of radiation is already foreseen.

Conclusions:

1. The use of piles for the production of radioactive tracers or radioactive sources should be considered to include those produced by fission as well as those produced by neutron bombardment of material foreign to the pile proper.

2. A large-scale and long-range C^{14} project, to include all steps from production to final biological utilization, should be initiated by the government to insure effective use of this tool in discovering the essential facts concerning the storage and utilization (photosynthesis and carbon metabolism) of solar energy.

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