Figure 5. Photograph of loose grain mounts of zircon from the tuffaceous mudstones (× nicols).

varies from stout small grains to those, with well developed elongate prismatic faces and short bipyramidal terminations.

The tuffaceous character of the mudstones becomes obscure where the detrital constituent assumes major proportions. In such thin sections, a population of framework grains of mica and quartz is seen to float in a matrix of argillaceous paste and micas.

It has been shown that there is a dominance in the occurrence of these altered tuff horizons in the Siwalik Group of Pakistan from 3.0 to 1.5 M.Y. B.P.[2]. It has also been indicated that this corresponds with the period of activity of the Dacht-e-Nawar volcanic complex of East-Central Afghanistan.

At the present time, we have not been able to obtain fission track dates for the zircon separates of our samples. But from the geological and magnetostratigraphic framework of this area[3,4], it is conjectured that the 2 tuffaceous mudstones in the Khetpurali section are post-Olduvai in age. However, in the Ghaggar section, the disposition of the tuffaceous mudstones as a couplet together with their stratigraphic occurrence towards the base of the Pinjor Formation allows for the inference that they correspond to the ash couplet dated between 2.4 and 2.5 M.Y.B.P. in the Siwalik Group of Pakistan[1,2].

It is also significant to point out that this report of tuffaceous mudstones lies almost 200 km farther to the east of those known earlier from the Jammu region. Late orogenic volcanism is not reported from the Himalaya. Following the line of argument present by earlier workers[2], it is suggested that these tuffaceous mudstones have been derived from the most westerly located volcanic centres (Dacht-e-Nawar Center) of Afghanistan. The Dacht-e-Nawar volcanic complex occurs in a large N-S trending graben in the Hazardadgat spur of the Hindu Kush[5]. This volcanic complex occurs 175 km southwest of Kabul and lies 1100 km to the west of Chandigarh.

If the inference regarding the source area of these occurrences is correct, the dimensions of the explosive volcanic activity would be significantly larger than what was thought of earlier.

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SIMPLE GLASS FERMENTOR FOR *RHIZOBIUM* CULTURE PRODUCTION

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IN India, rotary shakers are invariably used to cultivate *Rhizobium* in 1 litre conical flasks. Several such flasks containing liquid cultures of the bacterium serve as a source of inoculum. The rotary shaker method has limitations for bulk production of inoculants but

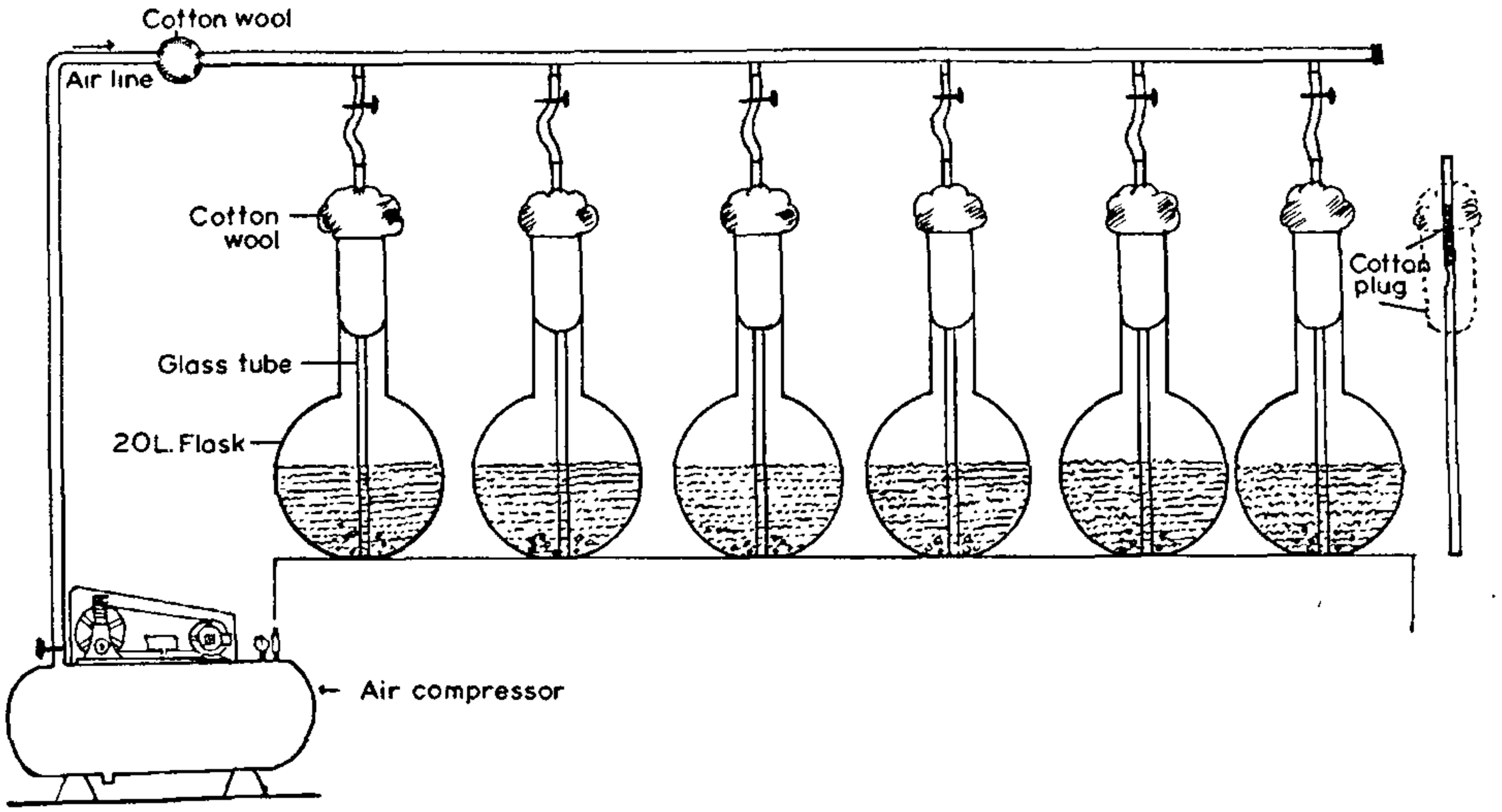

Figure 1. A simple glass fermentor for large scale cultivation of *Rhizobium*.

Table 1. *Growth of Rhizobium japonicum* (SB-16) in the glass fermentor.

Time (hr)	0	24	48	72
No. of viable rhizobia/ml of aerated culture solution ($\times 10^6$)	210	510	1040	2130

sophisticated fermentors are not only expensive but unnecessary for multiplication of rhizobial cells. Therefore, the authors have designed and successfully operated a simple inexpensive battery of glass fermentors, the details of which are given below.

Each glass fermentor consists of a 20 l round body and flat-bottomed Corning flask. Fifteen litres of yeast-extract-mannitol broth are formulated in the flask itself. The flask is plugged with a cotton roll through which passes a glass tube containing a tight cotton filter. The flask is sterilized at 15 psi pressure for an hour in a large autoclave. After cooling, the flask is inoculated aseptically with 1500 ml starter broth culture of *Rhizobium* which was initially grown on a rotary shaker. The glass tube of the fermentor is then connected to a compressor which has an air flow rate of 100 l/hr. A battery of such 20 l fermentors may be connected with a common airline depending on the air capacity of the compressor (figure 1). Table 1 shows data obtained indicating satisfactory growth of *Rhizobium japonicum* (SB-16) with 72 hr of growth[2].

The cost of each glass fermentor is approximately Rs. 600/-. The cost of the air compressor ranges from Rs. 2000–5000/-. The equipment is easy to handle and transparent to monitor changes in colour of the broth which may indicate possible contaminations. After 3–7 days incubation at 28°C (± 2°C), the broth culture is checked for quality by standard methods[1,2].

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