$La_{2-x}Sr_xCuO_4$ crystals, measured by powder X-ray diffraction using Si as a standard, are $a=3.793\pm0.003$ Å and $c=13.20\pm0.02$ Å, which are consistent with values obtained from a sintered $La_{1.88}Sr_{0.12}CuO_4$ feed rod ($a=3.792\pm0.003$ Å, $c=13.21\pm0.02$ Å). Electron probe microanalysis indicates that the Sr content is uniform throughout the crystal, with $x=0.12$; for the feed material, $x=0.15$.

Figure 2 shows the magnetic susceptibility of $La_{1.88}Sr_{0.12}CuO_4$ as a function of temperature, measured using a SQUID magnetometer. The transition temperature observed on cooling the sample in a magnetic field of 0.936 Oe agrees well with that from heating the zero-field-cooled superconducting phase through the transition in the presence of the same field; but the magnetization differs considerably between these two cases. The transition onset temperature and the end temperature are 37 K and 29 K respectively, so that the width of the transition, ΔT_c, is 8 K. This transition is considerably sharper than both that for sintered $La_{2-x}Sr_xCuO_4$ (ref. 2), and that reported previously for a $La_{2-x}Sr_xCuO_4$ single crystal. We found a Meissner effect of 13%.

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Isotope dating of the Australian regolith

SIR—The work reported[1] by Bird and Chivas is based on three assumptions: (1) that materials recognized as forming deeply weathered profiles have been formed at some time in the past, on landscapes of low relief under tropical conditions; (2) that the date of such intense periods of weathering can be established by a method of sufficient accuracy to calibrate their oxygen isotope results; and (3) that the clay minerals used for oxygen-isotope analysis were formed during the intense weathering process.

We investigated the first assumption at two sites. The first site was the laterites and deeply weathered profiles on the Hawkesbury Sandstone near Sydney. These materials are generally regarded as erosional remnants of a fossil soil, formed in the Miocene and/or Pliocene, under intense tropical weathering, on a surface of low relief [2,3]. Our mineralogical, geochemical and palaeomagnetic investigations[4–6] demonstrate that these laterites and associated deep-weathered profiles were formed during the gradual stripping of the impervious cover of the Wianamatta shales, which provided the necessary environmental conditions for the mobilization of iron. In other words, all the laterites are the result of a time-transgressive process controlled by the rate at which the Wianamatta shale is being stripped from the Hawkesbury Sandstone, whereas the deep-weathering profiles are explicable in terms of normal bedrock variability.

Our second site was in the Cobar region of central western New South Wales, where silcretes and associated deep-weathered profiles had been recognized[7,8] as having developed on a Tertiary pediplain. Detailed mineralogical and geochemical investigations of these materials[6,9] show that the quartzitic Palaeozoic bedrock of these sites has remained essentially unaltered since a late Palaeozoic deformation and that both silcretes and deep-weathered profiles can be explained in terms of normal bedrock variability.

Thus, even though the materials at these two sites have all the characteristics of deep-weathering profiles and associated laterites and/or silcretes, there is no necessary connection between such characteristics and their formation under some past tropical conditions.

Taking their second assumption, Bird and Chivas themselves[1] doubt the application of stratigraphic and palaeomagnetic methods. Yet they used these methods to calibrate the oxygen-isotope results. They do not comment on how the difficulties were dealt with to make the calibration meaningful. For example, in commenting on the use of stratigraphic methods, Bird and Chivas refer to Exon *et al.*[10] to support the view that previous attemtps to date Australian regolith have often been unsatisfactory. That paper, however, is only the last of a series which throws light not only on dating problems, but also on definitional problems.

The use of palaeomagnetism as a method of dating seems to be similarly flawed, for our investigation of iron in the Hawkesbury Sandstone[5,6] suggests that no past intensive period of iron deposition coinciding with a period of deep weathering can be identified. What is indicated is that iron mobilization and deposition has occurred at a fairly uniform rate over the whole basin since the late Tertiary at least, and this is more than sufficient to explain any of the present-day iron accumulations. Our work casts doubt on studies that have established intense periods of iron deposition at some time in the Tertiary, and in particular on the determinations used by Bird and Chivas to establish the age of periods of deep weathering.

Finally, the long-term stability of the oxygen-isotope composition of kaolinites is fundamental to their use by Bird and Chivas in identifying the time of formation of clay minerals. If this is so, it can equally be used to support the contention that in any weathering mass there is inevitably a contribution from inherited clay minerals, which, as we have shown for the materials derived from the Triassic Hawkesbury Sandstone and the Palaeozoic rocks of Cobar, can be the dominant factor. Even though the degree of inheritance is less in profiles developed on igneous rocks, inherited material will always be present. Bird and Chivas do not appear to have considered this factor.

These doubts about the application of the methodology to the dating of deeply weathered regolith lead us to question the significance of the three ages of weathering identified by Bird and Chivas. Such weaknesses must be resolved before any further progress can be made in the study of deeply weathered Australian regolith.

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BIRD AND CHIVAS REPLY—We fully agree with Paton *et al.* that the Australian regolith is a spacially and temporally complex entity, and that weathering remains a major surficial process on the Australian continent. Many of the points raised are valid, indeed obvious; but stringent space requirements precluded full discussion[1]. We discuss these points in detail in a forthcoming paper[11], so here we will only correct some of the misconceptions held by Paton *et al.*

Their statement of the suppositions on which the study was based is erroneous. The supposition we make is that the isotope composition of meteoric waters in Australia has been changing with time.

We do not state that lateritization/deep-weathering requires tropical conditions and low-relief landscapes (although such conditions may aid the process); in fact, a major conclusion of this and our other studies[12] is that tropical conditions are not required. We do state that such weathering requires humid conditions and unimpeded drainage, and that as a result, infiltrating waters are not likely to have been subject to evaporative modification of their isotope composition.

We do not believe that such profiles can be independently dated with great accuracy (except in exceptional circumstances, such as dated weathered basalt overlain by basalt) which is why we have delineated only three age groups, spanning probably 200 million years.

We are aware that weathering can be an episodic or continual process, that weathering 'events' can be superimposed in a single profile, and that clay minerals can be inherited from the parent rock (although large quantities of kaolinite are