

- 3 Huber, R and Bennet, W S, *Bionolymers*, 1983, 22, 261
- 4 Brook III, C L. and Karplus, M J, *J Molec. Biol.*, 1989, 208, 159
- 5 Doucet, J and Benoit, J P, *Nature*, 1987, 325, 643.
- 6 Caspar, D L D *et al.*, *Nature*, 1988, 332, 659.
- 7 Williams, R J P, *Eur J. Biochem.*, 1989, 183, 479
- 8 Kodandapani, R., Suresh, C. G. and Vijayan, M., *J. Biol. Chem.*, 1990, 265, 16126
- 9 Blake, C. C. F., Pulford, W. C. A and Artymiuk, P J, *J. Molec. Biol.*, 1983, 167, 693
- 10 Baker, E N and Hubbard, R E, *Prog Biophys. Molec. Biol.*, 1984, 44, 97.
11. Savage, H and Wlodawer, A., *Methods Enzymol.*, 1986, 127, 162.
- 12 Thanki, N., Thornton, J M. and Goodfellow, J. M., *J Molec. Biol.*, 1988, 202, 637.
13. Huxley, H E. and Kendrew, J. C., *Acta Crystallogr.*, 1953, 6, 76
- 14 Perutz, M F., *Proc R Soc.*, 1954, A225, 264.
- 15 Salunke, D. M., Veerapandian, B. and Vijayan, M., *Curr. Sci.*, 1984, 53, 231.
- 16 Salunke, D M *et al.*, *Acta Crystallogr.*, 1985, B41, 431.
17. Rao, S T., Hogle, J. and Sunderlingam, M., *Acta Crystallogr.*, 1983, C39, 237.
- 18 Rossmann, M G. (ed), *Molecular Replacement Method*, Gordon and Breach, New York, 1972.
- 19 Hendrickson, W. A and Konnert, J H., *Computing in Crystallography* (eds. Diamond, R., Ramaseshan, S and Venkatesan, K). Indian Academy of Sciences, Bangalore, 1980, pp. 1301-1326.
- 20 Blake, C. C. F. *et al.*, *Nature*, 1965, 206, 757
21. Imoto, T *et al.*, *The Enzymes* (ed. Boyer, P D.), Academic Press, New York, London, 1972, pp. 665-808
22. Ramanadham, M, Seiker, L. C and Jensen, L H. *Acta Crystallogr.*, 1990, B46, 63.
23. Kundrot, C. E. and Richards, F M, *J. Molec Biol.*, 1987, 193, 157
- 24 Kundrot, C. E and Richards, F M, *J Molec. Biol.*, 1988, 200, 401.
- 25 Nishikawa, K. *et al.*, *J. Phys. Soc. (Jpn)*, 1972, 32, 1331.
26. Sternberg, M. J. E., Grace, D. E. P. and Phillips, D C., *J. Molec Biol.*, 1979, 130, 231.
27. Ford, L. O *et al.*, *J. Molec. Biol.*, 1974, 88, 349.
28. Perkins, S J. *et al.*, *Biochem. J*, 1978, 173, 607.
29. Kelly, J. A *et al.*, *Nature*, 1979, 282, 875
- 30 Rossmann, M. G. and Argos, P, *J Biol Chem*, 1975, 250, 7525.
31. Johnson, C. K., ORTEP. Report ORNL-3794, Oak Ridge National Laboratory, 1970.

ACKNOWLEDGEMENTS. We thank Professor Sir D. C. Phillips for making available the refined atomic coordinates in the native tetragonal lysozyme. The atomic coordinates of high-pressure tetragonal lysozyme and triclinic lysozyme were obtained from Brookhaven Protein Data Bank. Our thanks are due to Dr R. Kodandapani for useful discussions. Two of the figures were prepared using the DEC version of ORTEP³¹, and two others with help from Mr R. Sankararamakrishnan and Ms K. P. Viji. The work was supported by the Department of Science and Technology, Government of India. One of us (Madhusudan) has been a CSIR fellow during the course of this work.

Received 22 November 1990; accepted 4 December 1990

RESEARCH COMMUNICATIONS

U-Au occurrence in Nogli Valley, Shimla District, Himachal Pradesh

R. V. Singh, D. B. Sen, R. K. Talra, R. K. Gupta and Rajendra Singh

Atomic Minerals Division, West Block VII, R. K. Puram, New Delhi 110 066, India

Anomalous gold values in association with uranium have been found in the Middle to Lower Proterozoic formations southwest of Kasha village in Nogli Valley, Himachal Pradesh. This is the first significant occurrence of gold from this part of the Higher Himalaya.

URANIUM occurrences in the Nogli Valley, Shimla District, Himachal Pradesh, are known since the early sixties¹ but gold mineralization, or uranium-gold association in particular, has not been reported so far from the Precambrian formations of this part of the Higher Himalaya. This note presents the first account of gold mineralization in association with uranium in the Rampur Group of rocks in the upper reaches of the Nogli Valley.

The area under reference occupies the southeastern

corner of the Rampur Window, about a kilometre south-southwest of Kasha village on the left bank of Nogli Gad (Figure 1). Stratigraphically the mineralization is confined within the Rampur Group of rocks, which are tectonically overlain by paragneisses and

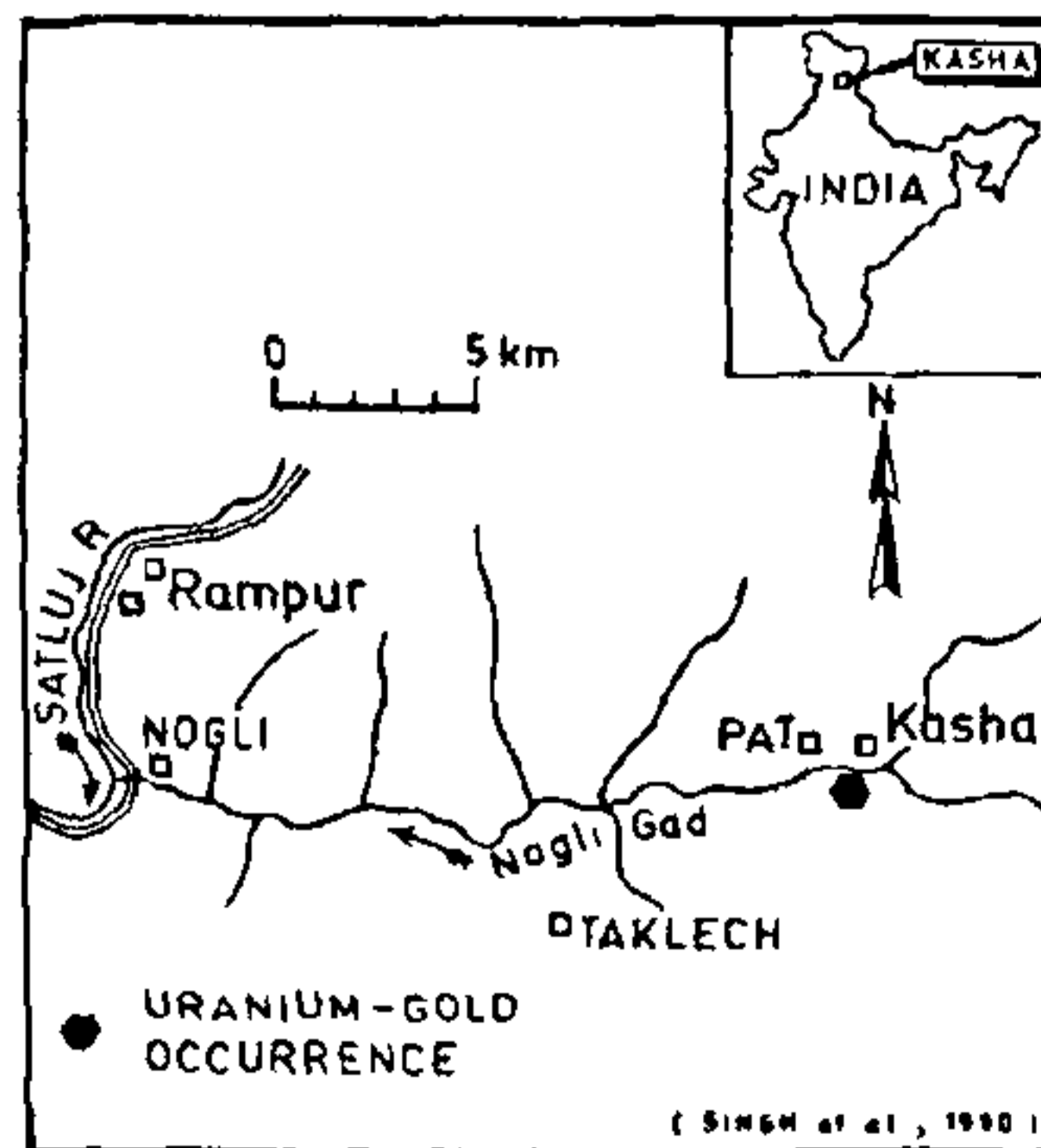


Figure 1. Location map of U-Au occurrence in Nogli Valley

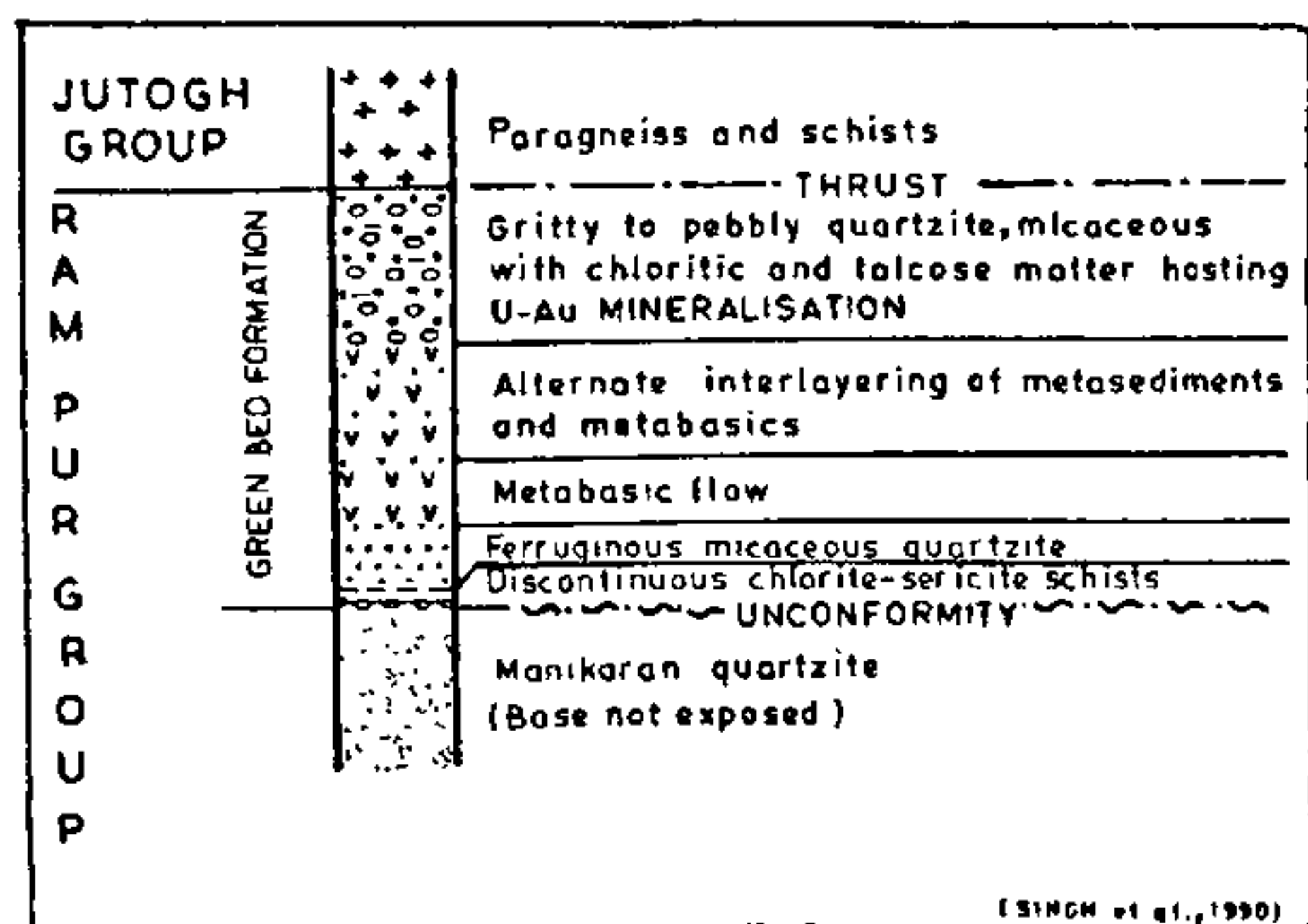


Figure 2. Lithotectonic sequence showing the position of U-Au mineralization in Nogli Valley.

schists of the Jutogh Group². The lithotectonic sequence indicating the position of the U-Au occurrence is shown in Figure 2.

Uranium and gold mineralization follow a NE-SW-trending shear zone dipping gently due SE and traceable intermittently for 650 m along a subvertical scarp. The host rock is a mylonite consisting of quartz, sericite and chlorite, with minor amount of biotite. Tourmaline, zircon, ilmenite, rutile, uraninite and black opaques occur as accessories. Sulphide minerals are conspicuously absent. The quartz grains indicate both metamorphic and igneous provenance, and are of two different sizes. The larger grains are occasionally pebbly in size, generally flattened, and aligned along the foliation, but at times also occur oblique to it. The flaky minerals veer around the larger quartz grains. Uranium minerals identified are uraninite and autunite. No discrete gold, however, could be observed under the petrological microscope.

Gold was determined by flameless atomic absorption spectrometry. The sample was decomposed with hydrofluoric acid, aqua regia and hydrobromic acid-bromine solution. Gold was extracted in methylisobutylketone from sample solution adjusted to 0.1 M hydrobromic acid. Final determination of gold was done using a Varian AA-475 atomic absorption spectrometer equipped with a Varian CRA-90 carbon rod atomizer. Uranium was determined by routine radiometric method.

Uranium and gold values have wide dispersion. The range, mean and standard deviation for 25 samples from this area are as follows:

	Range	Mean	Standard deviation
U ₃ O ₈ (wt %)	<0.01 to 1.0	0.217	0.381
Au (ppm)	0.03 to 20.00	0.32	0.768

The sample analysing 20 ppm gold has not been included in the calculations for mean and standard deviation.

Studies are in progress to evaluate the economic viability of this occurrence as well as paragenetic relationship of uranium and gold. The uranium-gold association enhances the resource potential of this area and opens up the possibility of locating gold mineralization in other parts of the Rampur Window and Himalaya under similar lithostructural settings. Airborne radiometric surveys could help in quick identification of such occurrences.

1. Saraswat, A. C. and Mahadevan, T. M., IAEA Technical Committee Meeting of Uranium Metallogeny, Vienna, 1987.
2. Bhargava, O. N., *Him. Geol.*, 1980, 10, 133.

ACKNOWLEDGEMENT. We thank Dr S. Viswanthan for valuable suggestions.

6 August 1990; revised accepted 24 September 1990

Fluorescence characteristics of 1,3-, 1,4-, 2,3- and 2,7-dihydroxynaphthalene radical cations

A. R. Baharvand, Z. H. Zaidi* and M. K. Machwet†

Department of Physics and Astrophysics, University of Delhi, Delhi 110 007, India

*Department of Physics, Jamia Millia Islamia, New Delhi 110 025, India

We have recorded excitation and fluorescence spectra of 1,3-, 1,4-, 2,3- and 2,7-dihydroxynaphthalene radical cations in a rigid matrix. While the parent compounds give rise to broad and structureless emission bands, the ionic spectra exhibit, in addition to an intense band, a few weaker bands. Excitation wavelength and fluorescence maxima for the cations are shifted towards longer wavelength compared to those for the parent molecules. The characteristic features of the spectra are explained in relation to the position of -OH groups in the molecule.

MANY naphthalene derivatives are fluorescent, a property attributed to π -electron excitation. A substituent group such as -OH has unshared electron pairs that can be transferred into vacant π orbitals belonging to the aromatic ring. This effectively raises the ground-state energy of the π -electron system. Thus the absorption and fluorescence of the -OH-substituted molecule occur at lower frequencies. When two donor groups are attached to the aromatic ring, the positions of absorption and fluorescence bands are usually

†For correspondence.