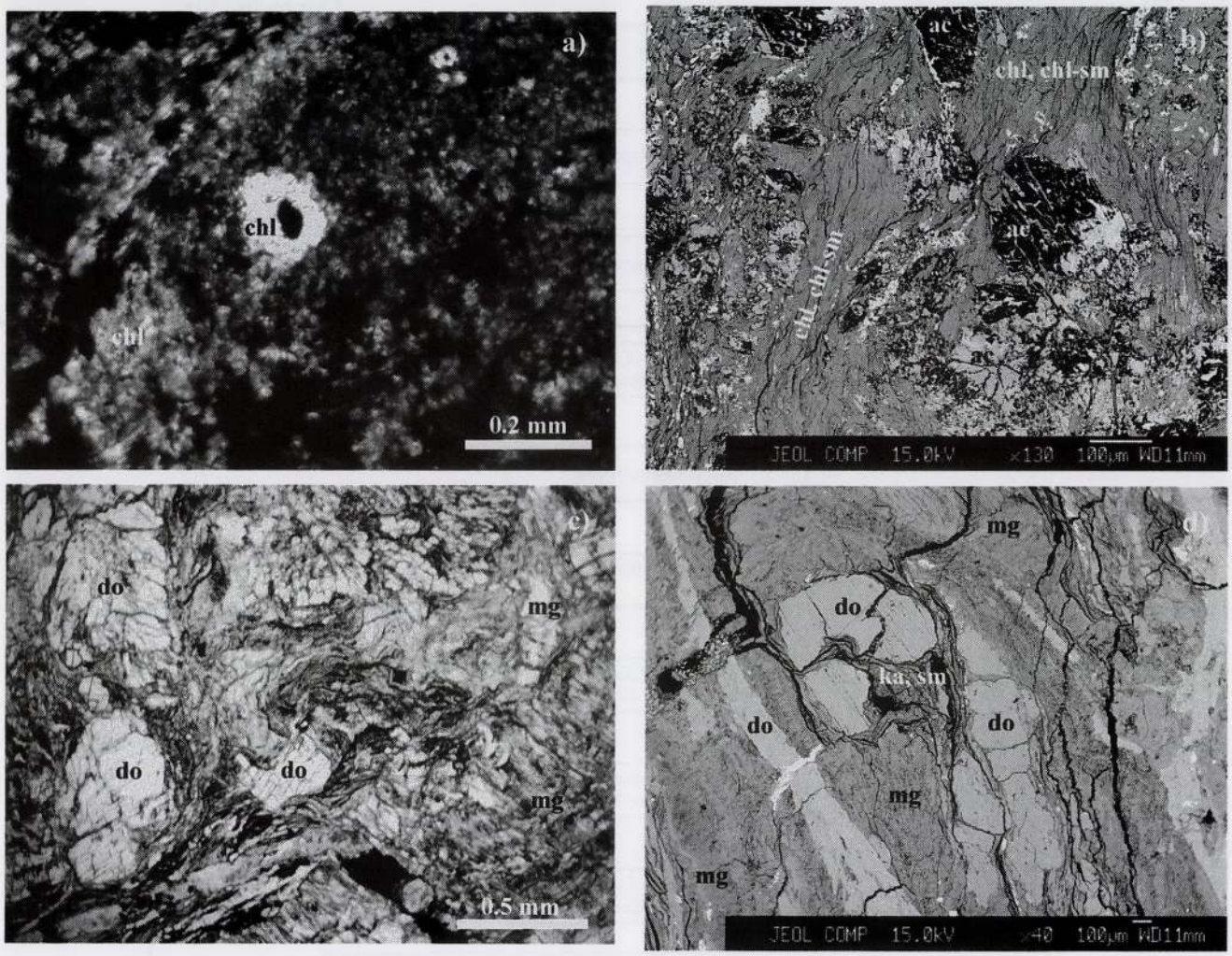

FIG. 3. Microscopic photograph (open nicol) and BSE images of the thin sections made of the impregnated specimens. a) and b) the weathered metabasite. c) and d) the hydrothermally altered pelite. See caption of Fig. 1 for explanation of abbreviations.

for HRTEM observations are selected from the thin sections (Fig. 3). In our technique, Mo-grids are adhered onto the selected areas in the thin sections using the epoxy adhesive (standard Araldite). In the conventional technique, the entire area of the thin sections was detached from the glasses subsequent to being heated at a temperature range from 110 to 120°C, and these sections were not reusable. In certain cases, the detached thin section shrank and curled due to heating. Additionally, the surplus balsam is required to be extracted using organic solvents such as xylene and acetone.

In our technique, after the epoxy adhesive is cured, an incision is made in the thin section around the Mo-grids using a cutter knife. The thin sections are then placed into a plastic case filled with hot water *ca.* 70°C, and only Mo-grids with the selected areas can be detached from them within a few seconds. The surplus wax on the detached Mo-grids can be washed away in the hot water. In this technique, only the required area can be obtained from the thin section, as shown in Fig. 4, indicating that the thin section prepared by our technique is reusable (Fig. 2).

The detached Mo-grid is thinned to electron transparency via argon ion milling. A JEOL-2010 transmission electron microscope operating at 200 kV is used for observing lattice fringe images. A part of the observed lattice fringe images is shown in Fig. 5.

CONCLUSION

Our simple preparation technique using the diluted epoxy-resin and adhesive wax enables us to successfully prepare the ultra thin films of fragile specimens for HRTEM observations. The advantages of our preparation technique are as follows: 1) the complete impregnation of a fragile specimen can be attained, 2) heating damage to the specimens is minimized and 3) only the required area can be obtained from the petrographic thin section.

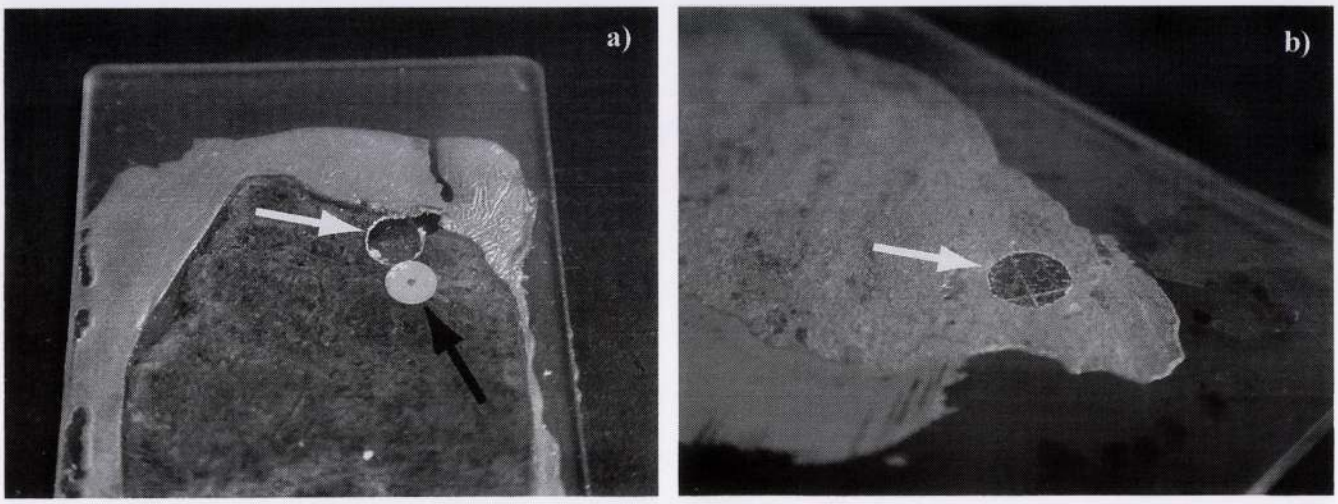

FIG. 4. Adhered Mo-grid on thin section is indicated by black arrow. Only adhered Mo-grid can be detached in hot water (white arrow). a) the weathered metabasite. b) the hydrothermally altered pelite.

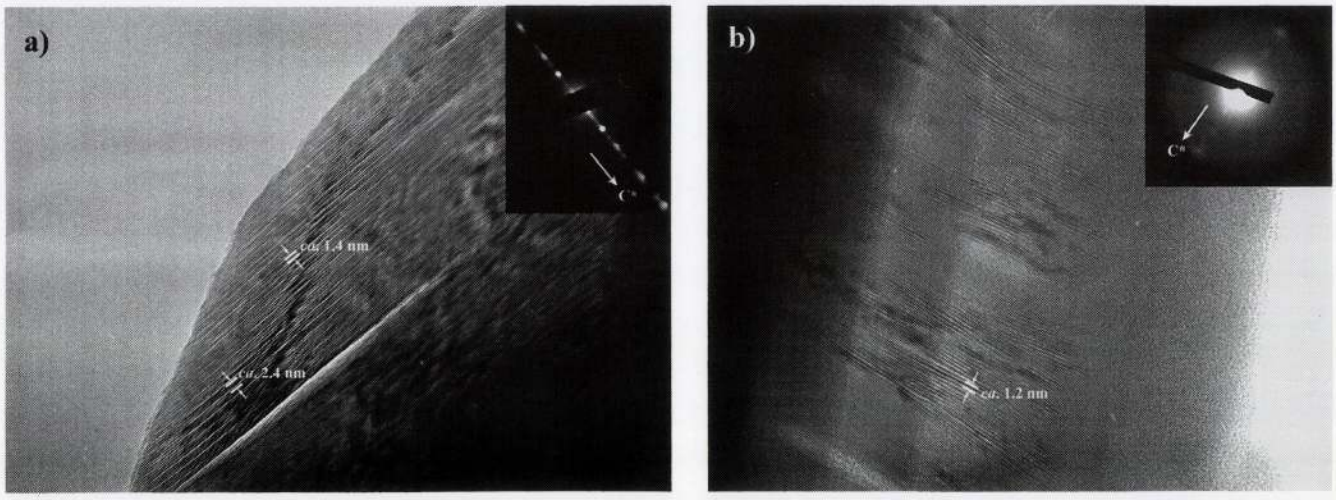

FIG. 5. HRTEM images. a) the weathered metabasite. Corrensite-like layer (*ca.* 2.4 nm) prevail in this image. Chlorite-like layer (*ca.* 1.4 nm) is also recognized. b) the hydrothermally altered pelite. Smectite-like layer (*ca.* 1.2 nm) is observed.

ACKNOWLEDGEMENTS

We would like to thank for Dr Ando, J. for his help during HRTEM work. Thanks are also due to Shibata, Y. for his help during EPMA work. We are indebted to Assistant Prof Kitagawa, R. and Dr Jige, M for their useful discussion and helping in the improvement of this manuscript.

REFERENCES

AHN, J.H. and PEACOR, D.R. (1989) Illite/smectite from Gulf Coast shales: A reappraisal of transmission electron microscope images. *Clays and Clay Minerals*, **37,** 542–546.

AMOURIC, M. and OLIVES, J. (1991) Illitization of smectite as seen by high-resolution transmission electron microscopy. *European Journal of Mineralogy*, **3,** 831–835.

AMOURIC, M. and OLIVES, J. (1998) Transformation mechanisms and interstratification in conversion of smectite to kaolinite: an HRTEM study. *Clays and Clay Minerals*, **46,** 521–527.

KOGURE, T. (1996) Investigation of alteration processes of biotite by high resolution electron microscopy. Doctoral thesis, The University of Tokyo, 100p.

MURAKAMI, T., SATO, T. and WATANABE, T. (1993) Microstructure of interstratified illite/smectite at 123 K: A new method for HRTEM examination. *American Mineralogist*, **78,** 465–468.

NIETO, F., VELILLA, N., PEACOR, D.R. and HUERTAS, M.O. (1994) Regional retrograde alteration of sub-greenschist facies chlorite to smectite. *Contributions to Mineralogy and Petrology*, **115,** 243–252.

SHAU, Y.-H., PEACOR, D.R. and ESSENE, E. (1990) Corrensite and mixed-layer chlorite/corrensite in metabasalt from northern Taiwan: TEM/AEM, EPMA, XRD, and optical studies. *Contributions to Mineralogy and Petrology*, **105,** 123–142.

VICENTE, M.A., ELSASS, F., MOLINA, E. and ROBERT, M. (1997) Palaeoweathering in slates from the Iberian Hercynian Massif (Spain): investigation by TEM of clay mineral signature. *Clay Minerals*, **32,** 435–451.