REFERENCES

REFERENCES

Aranyakanon, P., 1961, "The Cassiterite Deposit of Haad Som Pan, Ranong Province, Thailand", Report Invest. no.4, Roy. Dept. Mines, Bangkok, Thailand, 182 p.

_____, 1969, "Tin Deposits in Thailand", proc. 2nd Tech. Conf. on Tin (Fox, W. ed), Bangkok, v.1, p.81 - 102.

Beckinsale, R.D., Suensilpong, S., Nakapadungrat, S. and Walsh, J.N., 1979, "Geochronology and Geochemistry of Granite Magmatism in Thailand in Relation to a Plate Tectonic Model", Jour. Geol. Soc., London, v.136, p.529 - 540.

Branshaw, P.M.D., 1967, "Distribution of Selected Elements in Feldspar, Biotite and Muscovite from British Granite in Relation to Mineralization", Inst. Min. Metal. Trans., v.76, sec.B, p.137 - 148.

Brown, G.F., Buravas, S., Charaljavanaphet, J., Jalichandra, N., Johnston, W.D., Sresthaputra, V. and Taylor, G.C., 1953, "Geological Reconnaisance of the Mineral Deposits of Thailand", U.S. Geol. Surv. Bull. 984, 183 p.

Burnhan, C.W., 1979, Magma and Hydrothermal Fluids in Geochemistry of Hydrothermal Ore Deposits (Barnes, H.L. ed.), John Wiley & Sons, p.71 - 136.

Chancharoonpong, K., 1970, "Report of Investigation on the Tin Deposits of Takoe Pit Thong Area, Rachaburi," Dept. Min. Res., Bangkok, Thailand, 4p. (unpubl. in Thai).

Chappell, B.W., and White, A.J.R., 1974. "Two Contrasting Granite Types", Pacific Geol., v.8, p.173 - 174.

Charoensri, P., 1983, "The Major Tungsten Districts of Thailand", Preprint of Conf. Geol. Miner. Thailand, Dept. Min. Resour., Bangkok, 10 p.

Charusiri, P., 1980, "Igneous Complexes and Tin Mineralization in Phuket Island, with Special References to Chao Fa and Tor Soong Mines", Master's Thesis, Department of Geology, Graduate School, Chulalongkorn University, 208 p. (unpub).

_____, and Pongsapich, W., 1982, "Geology and Petrochemistry of Some Granites of Phuket Island", Department of Geology, Chulalongkorn University, Report No.6, 34 p.

Dheeradilok, P., 1974, "Geology of The Sheet Amphoe Thonburi", Proceeding of the Conference on Geology and Mineral Resources, Department of Mineral Resources, Bangkok, p.167 - 182.

Dheeradilok, P., (compiled), 1981, Geologic Map of Nakon Pathom Quadrangle No. ND 47 - 11, Department of Mineral Resources, Bangkok.

El Bouseily, A.M. and El Sokkary, A.A., 1975, "The Relation between Rb, Ba and Sr in Granitic Rocks", Chem. Geol., v.16, p.207 - 219.

Ewers, G.R. and Scott, P.A., 1977, "Geochemistry of the Gullen Granite, Northern Territory", BMR Jour. Australian Geol. & Geophys., v.2, p.165 - 516.

Ferrow, E. and Annersten, H., 1984, "Ferric Iron in Tri-Octahedral Micas", Univ. Uppsala Dept. Mineralogy & Petrology Res. Rep. p.39.

Grout, F.F., 1924, "Notes on Biotite", Am. Mineral., v.9, p.159 - 165.

Groves, D.I., 1972, "The Geochemical Evolution of Tin-bearing Granites in the Blue Tier Batholith, Tasmania", Econ. Geol. v. 67, p.445 - 457.

_____, and Taylor, R.G., 1973, "Greisenization and Mineralization at Anchor Tin Mine, Northeast Tasmania", Trans. Inst. Min. Met., section B (Applied Earth Science), B135 - B136.

Guidotti, C.V., 1984, Micas in Metamorphic Rocks in Micas. (Bailey, S.W., ed.), Reviews in Mineralogy v.13, Min. Soc. Am., p.452.

Hall, A.J., 1941, "The Relation between Color and Chemical Composition in the Biotites", Am. Mineral., v.26, p.29 - 33.

Hansawek, R., 1983, "Petrochemical Features of Granites Associated with Tin-Tungsten Mineralization at Mae Chedi, Wiang Pa Pao, Chiang Rai", Master's Thesis, Department of Geology, Graduate School, Chulalongkorn University, 127 p. (unpub).

Harker, A., 1932, "Metamorphism", Methuen, London.

Hayama, Y., 1959, "Some Considerations of the Color of Biotite and its Relation to Metamorphism", J. Geol. Soc. Japan , v.65, p.21 - 30.

Heir, K.S. and Billing, G.K., 1970, Rubidium in Handbook of Geochemistry (Wedepohl, W.H. ed.), Springer Verlag, New York, p.54.

Hosking, K.F.G., 1970, "The Primary Tin Deposits of South-East Asia", Minerals Sci. Engng. 1970 B, v.1, p.24 - 50.

Hosking, K.F.G., 1981, The Tin-Bearing Minerals of Southeast Asia in Complex Tin Ores and Related Problems (Abdullah Hasbi bin Haji Hassan and Hubertus van Wees eds.), SEATRAD Centre, Ipoh, Malaysia, p.17 - 65.

Jackson, K.J. and Helgeson, H.C., 1985 a, "Chemical and Thermodynamic Constraints on the Hydrothermal Transport and Deposition of Tin : II. Interpretation of Phase Relations in the Southeast Asian Tin Belt", Econ. Geol., v.80, p.1365 - 1378.

Jackson, K.J. and Helgeson, H.C., 1985 b, "Chemical and Thermodynamics Constraints on the Hydrothermal Transport and Deposition of Tin : I. Calculation of the Solubility of Cassiterite of High Pressures and Temperatures", Geochem. et Cosmochem Acta, v.49, p.1 - 22.

Lay, J.R., 1985, "The Position of Thailand in the International Tin Business", Proceeding of the Conference on Applications of Geology and the National Development (Thiramongkol, N., Nakapadungrat, S. and Pisutha-Arnond, V. eds.), Department of Geology, Chulalongkorn University, p.45 - 60.

Mahawat, C., 1982, "The Petrology and Geochemistry of the Granitic Rocks of the Tak Batholith, Thailand", Ph.D. Thesis, University of Liverpool, U.K., 210 p. (unpub).

Nakapadungrat, S., 1982, "Geochronology and Geochemistry of the Thong Lang Granite Complex, Central Thailand", Ph.D. Thesis, Univ. of London, U.K., 336 p. (unpub).

Nakapadungrat, S., Beckinsale, R.D. and Suensilpong, S., 1985, "Geochronology and Geology of Thai Granites", Proceeding of the Conference on Applications of Geology and the National Development (Thiramongkol, N., Nakapadungrat., S. and Pisutha-Arnond,V. eds.), Department of Geology, Chulalongkorn University, p.75 - 93.

Norman, D.I. and Trangcotchasan, 1982, Mineralization and Fluid Inclusion Study of the Yod Nam Tin Mine, Southern Thailand in Metallization Associated with Acid Magmatism (Evans, A.M. ed.), John Wiley & Sons Ltd., p.261 - 278.

Nutalaya, P., 1972, Geologic Map of the Takoe Pid Tong Area, 1:12,500 scale map, (unpub).

Olanratmanee, K., Raengpholsumrit, P. and Tulathamkul, K., 1983," Report of Geophysical Investigation at the Takoe Pit Thong Tin Deposits, Ratchaburi (with Geologic Map scale 1:15,000)", Department of Mineral Resources, Bangkok, 5 p. (unpub. in Thai).

Partin, E., Hewitt, D.A. and Wones, D.R., 1983, "Quantification of Ferric Iron in Biotite", Geol. Soc. Am. Abstr. with Programs, v.15 p.659.

Patterson, D.J., Ohmoto, H. and Solomon, M., 1981, "Geologic Setting and Genesis of Cassiterite-Sulfide Mineralization at Renison Bell, Western Tasmania", Econ. Geol., v.75, p.173 - 183.

Pitragool, S. and Panupaisal, S., 1979, "Tin and Tungsten Mineralization of the Mae Lama Mining District, N-W Thailand", Geol. Soc. Malaysia Bull, 11, p.267 - 281.

Pungrassami, T., 1984, "Tin Mineralization of the Thung Pho-Thung Khamin Mining District, Changwat Songkla", Proceeding of the Conference on Applications of Geology and the National Development (Thiramongkol, N., Nakapadungrat, S. and Pisutha-Arnond, V. eds.), Department of Geology, Chulalongkorn University, p.207 - 214.

Punyaprasiddhi, P., 1980. "Investigation of the Geology and Mineralization of Tin and Tungsten at Samoeng Mine Area North Thailand", Ph.D. Thesis, Univ. Sheffield, U.K., 130 p. (unpub).

Puttapiban, P. and Gray, C.M., 1983, "Age and Tin-Tungsten Mineralization of the Phuket Granites, Thailand", Preprint of Conf. Geol. Miner. Resour. Thailand, Dept. Min. Resour., Bangkok, 10 p.

Sheraton, J.W. and Labonne, B., 1978, "Petrology and Geochemistry of Acid Igneous Rock of Northeast Queenland", Bureau Miner. Res., Australia, Bull, 169, 139 p.

Suensilpong, S., Burton, C.K. and Mantajit, N., 1978, "Geological Evolution and Igneous Activity of Thailand and Adjacent Areas", Episodes, No.3, p. 7.

Tantisukrit, C., 1978, "Review of the Metallic Mineral Deposits of Thailand", Proc. 3rd Reg Conf. Geol. Miner. Resour. SE Asia (Nutalaya, P. ed.), p.783 - 793.

Tauson, L.V. and Kozlov, V.D., 1973, "Distribution Functions and Ratios of Trace-element Concentration as Estimates of the Ore-bearing Potential of Granites", in Geochemical Exploration 1972, Proc. 4th Int. Geochem. Expl. Symp. London, Inst. Min. Met. p.37 - 44.

Taylor, S.R., 1965, "The Application of Trace Element Data to Problem in Petrology", Phys. Chem. Earth, v.6, p.133 - 213.

Taylor, S.R., 1968, "Leucogranites and Rhyolites : Trace Element Evidences for Fractional Crystallization and Partial Melting", Lithos, v.1, p.179 - 186.

Tilley, C.E., 1926, "On Some Mineralogical Transformations in Crystalline Schist", Mineral. Mag., v.21, p.34 - 46.

Thornton, C.P. and Tuttle O.F., 1960, "Chemistry of Igneous Rocks : I. Differentiation Index", Am. Jour. Sci., v.258, p.664 - 684.

Tutlle, O.F. and Bowen, N.L., 1958, "Origin of Granite in the Light of Experimental Studies in the Systems $NaAlSi_3O_8$ - $KAlSi_3O_8$ - SiO_2 - H_2O", Geol. Soc. Am., v.74, 153 p.

Vichit, P., 1983, "Tin Deposits of Northern Thailand", Preprint of Conf. Geol. Miner. Resour. Thailnd, Dept. Min. Resour. Bangkok, 10 p.

Wones, D.R. and Eugster, H.P., 1965, "Stability of Biotite : Experiment, Theory, and Application", Am. Mineral, v.50, p.1228 - 1272.

Wright, J.B., 1969, "A Simple Alkalinity Ratio and its Application to Questions of Non-Orogenic Granite Genesis", Geol. Mag., v.106, p.370 - 384.

APPENDIX

APPENDIX

Geochemical Techniques

X-ray Fluorescence method was mainly used for geochemical analysis of rocks for major element-oxides (Table 1) and trace elements (Table 2). The combined water (H_2O^+) and ferrous iron (FeO) were determined by a modified Penfield Method and volumetric method, respectively.

Preliminary Treatment of the Rock Sample

Fresh samples were carefully selected used for chemical analysis. The large sample was broken and pieces. Using a jaw crusher, the samples were crushed into small chips of about 2 - 3 mm. The crushed sample of about 100 gm was then pulverized to 200 - 250 mesh by a tungsten-carbide barrels on a crusher for 3 - 5 minutes. The powder sample was homogenized by mixing on the glazed paper and sampling by cone splitting.

Preparation of Glass Bead

1. Take 4 gm. of powder sample in an oven for two hours at 120 ^{o}C.

2. Weigh the dry sample.

3. Weigh the powder sample exactly 1.5 gm. in a platinum crucible (platinum/gold 95/5%). Add 7.5 gm. of a mixture of anhydrous spectromelt (mixing the equal amount of lithium metaborate

and lithium teraborate flux to the sample with the ratio 5:1) and mix sample and spectromelt with a glass rod in the platinum crucible.

4. Put the platinum crucible on a Harzog burner for ten minutes at 1100 ^{o}C.

5. Take the bead out of the platinum crucible and write down the sample number after cooling has completed.

The glass bead was homogenized by the way of this method and used for the determination of major element oxides and trace elements by X-ray Fluorescence.

X-ray Fluorescence Method

The X-ray Fluorescence spectrometry is used for determining the element that present in a rock sample. The principle of this method is that when an element is a multi component sample is bombarded with primary X-ray photon, secondary X-ray photons characteristic of this element are produced. These secondary of fluorescent X-rays are then dispersed according to their wave lengths. This is achieved by using a crystal of known d-spacing where diffraction takes place according to Bragg's relationship $n = 2d\sin\theta$ where is the wavelength, d is the spacing between the planes of the crystal. The intensity of the diffracted fluorescent radiation is then measured, and the concentration of the element producing this radiation can be found, since the intensity is proportional to concentraton.

The sample analysis was carried out on a philips (PW. 1400) automic X-ray spectometer with computerized system at Analytical Laboratory Section, Geological Survey Division; Department of Mineral

Resources. The technique used in this work was the fusion method for glass-bead sample. The homogeneity and the surface of samples are to be in great case.

The regression analysis was applied also with the matrix corrections. These are carried out on onlined-phillips computer.

Determination of Combined Water (H_2O^+)

The combined water (H_2O^+) of the rock samples were determined by a modified Penfield Method. The procedure of the analytical technique is as follows:

1. Place 3 gm. of sodium tungstate fiux and 1.000 gm. of the sample in a porcelain crucible and mix them thoroughly with a glass rod. Using a long-stemmed funnel, completely transfer this mixture into the bulb of a dried Penfield tube. Close the tube with a capillary stopper.

2. Horizontally insert the bulb of the Penfield tube, with a strip of damp cloth spirally wrapped around the middle sector, into the open flame from a bunzen burner. Slowly rotate the tube while heating the bulb at red-heated for 30 minutes. Keep the cloth wet throughout the heating period.

3. Heat the juncture of the tube until it softens. Pull off the bulb with iron tongs, and heat the sealed end of the tube for a few seconds to round of the sharp tip.

4. Let the tube cool, unwrap the damp cloth, and blot the water from the outside of the tube with a towel. Remove the stopper and weight the tube (tube weight plus weight of combined water).

5. Dry the tube in an oven at 100 ^{o}C for 1 hour. Let the tube cool and weight of the tube during drying.

Determination of Ferrous Iron

Ferrous iron was determined by volumetric method. The sample powder was treated with hot hydrofluoric and sulphuric acids. The contents of the platinum crucible were then transferred to a beaker containing a mixture of sulphuric, phosphoric and boric acids. The mixture was then titrated with potassium dichromate, until the indicator, sodium diphenylamine sulphonate assumed a permanent purple color. Fe_2O_3 was calculated from total Fe_2O_3 and FeO by using the relationship : Fe_2O_3 = total Fe_2O_3 - (FeO x 1.1113). This method was fast and direct, no comparisons were made with other rocks. The presence of sulphides or organic matter rendered an accurate determination of ferrous iron impossible. None of these components presented any serious problem in any of rocks analysed.

BIOGRAPHY

Mr. Amarit Suvunsavate was born in Nakon Sri Thamarat, Thailand, on May, 25, 1947. He graduate with a B.Sc. in Geology from Chiangmai University, Chiangmai in 1970. Then he worked in Materials and Research Division, Department of Highways until 1975. During he worked in the said Division, he attemped to apply geological knowledge i.e. aerial photo interpretation, geophysical investigation to serve engineering work. From 1975 - 1984, he worked in Mining Division, Mines Organization. He served as Mining Geologist at Pilok mine, Chief of Exploration Section, Huai Yod Mine Manager, Changwat Trang and Senior Geologist, respectively. At present, he has worked as a Mining Geologist in the Viriya Industry Co. Ltd., Bangkok.