CHAPTER I

INTRODUCTION

1.1 General statement

Nowadays rough gem materials, especially ruby and sapphire, have been imported to Thailand. This is an important fact for the gem industry of the country, because gem production has been decreased rapidly in last few decades. East Africa has abundant gem corundums that have been extensively mined and exported to Thailand since 1997. Among those African countries, Tanzania is a significant gem and precious metal producer. Values of gem imported from Tanzania are presented in Table 1.1 (www.customs.go.th). Tanzania has produced varieties of gem (e.g. diamond, corundum, emerald, tanzanite, garnet, tourmaline, spinel, alexandrite and zircon). Corundum is the most significant gem material for Thai gem and jewelry industries; therefore, Tanzania is an interesting source. In addition, many corundum deposits have been discovered in Tanzania; some of them are commercially mined.

Songea area is a new corundum deposit in Tanzania, so only a few gem research of this deposit has been published. Their principle characteristics (e.g. physical properties, internal features and chemical composition) are quite interesting and crucial information for gem market and academic. Therefore, this research project was designed to characterize some corundum from Songea deposit in details. All basic gem equipments were applied to collect properties (e.g. specific gravity, refractive index, and internal feature). Moreover, spectroscopic investigations were obtained by UV-VIS-NIR and Fourier Transform Infrared Spectrophotometer (FTIR); they show absorption patterns that are implied to the causes of color in corundum samples. Energy Dispersive X-ray Fluorescence (EDXRF) Spectrometer (semi-quantitative analysis) and Laser Ablation-Inductively Coupled Plasma-Mass Spectrometer (LA-ICP-MS) for quantitative analysis were used to analyze major and minor trace elements in the corundum. Besides, mineral inclusions found in corundum were chemically analyzed by Electron Probe Micro-Analyzer (EPMA). All information obtained from this study was used to specify characteristics as well as genesis of Songea corundum. In addition, heat treatments were additionally carried out because they may be useful for gem industry and trade that may be used to improve the quality of Songea corundum and recognize treated stone.

Table 1.1 Value of gems imported from Tanzania in 2001-2004. (www.customs.go.th)

Years / Materials	Jan-Dec 2001	Jan-Dec 2002	Jan-Dec 2003	Jan-Dec 2004
Rough stone				
ruby	-	13,928,244	2,857,380	2,140,557
sapphire	6,390,185	10,490,938	5,805,982	7,224,966
Total (Thai bath)	6,390,185	24,338,182	8,663,362	9,365,523
Cut stone				
ruby	-	1,818,865	4,341,910	7,396,278
sapphire	258,936	3,119,738	5,697,222	77,475,573
emerald	-	1,139,599	248,894	5,635,648
Total (Thai bath)	6,449,121	6,078,202	10,288,026	90,507,499

1.2 Purposes

The main objective of this research is to study characteristics, particularly physical properties and internal features of some corundum from Songea deposit, Tanzania. The study is carried out by using both basic and advanced gem-testing instruments. Results expected from the study are used to compare with those of corundums from other significant localities. Then specific characteristics of Songea corundums will be pointed out. Perhaps, some characteristics may lead to interpretation of their genesis. In addition, heat treatment and altered features after heating of these samples are additionally included to gain crucial information for industry.

1.3 Methodology

Method of study was consequently designed to reach the target; that can be summarized in Figure 1.1 and described below.

1. Literature survey: geology of Tanzania and corundums deposits in Tanzania and Africa were initially reviewed. The Tanzania geological framework could give basic knowledge about gem genesis, host rock and some properties.

2. Sample classification: corundum samples from Songea generally have wide range of colors (e.g. red, red orange, orange, violet, violet blue, blue, purple, purple red, yellow, yellow green, green and colorless). In addition, many of them show color patch or

color zoning. Therefore, samples under this study were initially classified into main color groups before giving color codes by comparison with GIA Gem Set. Consequently, detailed studies of their properties were carried out.

3. Physical and optical properties: general measurements and observation, e.g. size, weight, specific gravity, refractive indices, color-change effects in daylight and incandescent light, were subsequently carried out. In addition, luminescence phenomena under ultraviolet lamp and cathodoluminescence were also observed.

4. Internal features were observed firstly under microscope. Samples containing mineral inclusions were polished until those inclusions were exposed to the surface for detailed investigation using Laser Raman Spectroscopy model 1000, Renishaw Ar LASER 514 nm (green) and 621 nm (red) at the Gem and Jewelry Institute of Thailand (GIT). Subsequently, Electron Probe Micro-Analyzer (EPMA) at Macquarie University, Australia was used for the analysis of mineral chemistry of these inclusions.

5. Absorption spectra were obtained using UV-VIS-NIR spectrophotometer model U-4001, Hitachi at GIT. The absorption patterns would help understand the causes of color in thy samples.

Fourier Transform Infrared spectrophotometer (FTIR) model NEXUS 470 FT-IR ESP based at Department of General Science, Faculty of Science, Kasetsart University was used to study Infrared absorption patterns belonging to some specific bonding such as O-H stretching. This set of information may be useful for heating experiment.

6. Trace elements: semi-quantitative analysis using Energy Dispersive X-ray Fluorescence (EDXRF) Spectrophotometer at GIT was initially performed on the samples in all color groups before some selected samples were analyzed quantitatively using Laser Ablasion-Inductively Coupled Plasma-Mass Spectrometer (LA-ICP-MS) at Macquarie University, Australia. Trace element analyses from EDXRF will be comparing with EDXRF analyses of corundums from elsewhere, besides quantitative trace elements will be used to characterize and interpret the causes of color and effect of heating experiment.

7. Heat treatment: heat treatment experiment was also carried out to get more information about the interaction of the stones with heat that would be useful for gem industry. The experiment was set by using optimum conditions that have been done by previous researchers. Finally, all data obtained from the experiment will be discussed.

8. Discussion and conclusion will be carried out in different aspects including characteristics (e.g. optical properties, internal features and chemical composition) of Songea corundums, genesis and heat treatment. Eventually, all information obtained from each part will be reported.

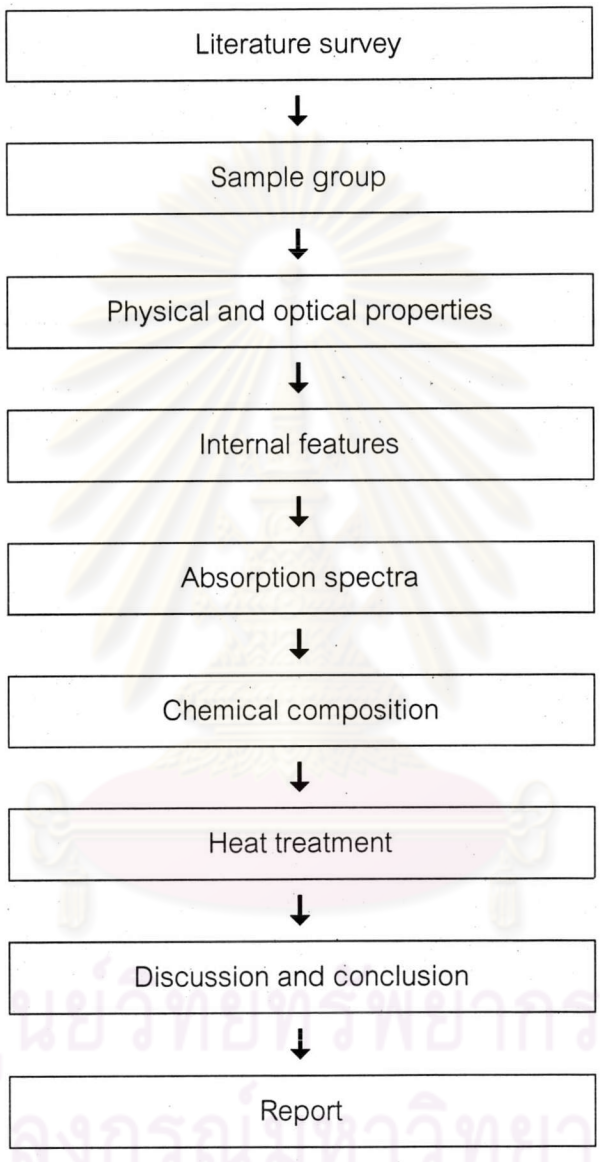

Figure 1.1 Flow-chart diagram showing methods of this study.