SARI

Cekungan Limboto merupakan cekungan yang berada di bagian tengah Lengan Utara Sulawesi. Karakteristik cekungan ini sangat kompleks dengan keberadaan batugamping berumur Tersier Akhir. Kondisi ini menjadi tantangan untuk melakukan penelitian lebih detail terhadap keberadaan batugamping Limboto. Penelitian batugamping ini sekaligus membantu mengungkap misteri genesa terbentuknya Cekungan Limboto yang hingga sampai saat ini masih simpang siur.

Tujuan utama penelitian ini antara lain menganalisis fasies, lingkungan pengendapan, umur relatif batugamping, proses dan lingkungan diagenesa batugamping Limboto serta membuat model cekungan Limboto. Upaya untuk mencapai tujuan penelitian tersebut maka digunakan empat metode dan analisis penelitian. Keempat metode dan analisis penelitian terdiri dari stratigrafi terukur, analisis petrografi, analisis biostratigrafi dan analisis geologi struktur (tektonik).

Hasil penelitian ini menghasilkan temuan baru mengenai fasies dan lingkungan pengendapan. Fasies batugamping Limboto terdiri dari lima fasies. Fasies *coralline rudstone* dan *coralline floatstone* (SMF 24) dengan lingkungan *platfom interior restricted* (FZ 8). Fasies *bioclastic rudstone* (SMF 12) dengan lingkungan *platform margin sands shoals* (FZ 6). Fasies *foraminiferal wackestone* (SMF 9) dan perselingan *wackestone-packstone* (SMF 10) dengan lingkungan *platform interior open marine* (FZ 7).

Umur batugamping Limboto berdasarkan hasil analisis biostratigrafi adalah Miosen Akhir-Pliosen Awal mengacu pembagian tiga zonasi biostratigrafi. Zona kisaran sebagian *Globorotalia acostaensis* (PL1/ N18), zona selang *Pulleniatina primalis-Globoquadrina dehiscens* (M14/N17b) dan zona kisaran sebagian *Globorotalia plesiotumida* (M13b/N17a).

Proses diagenesis batugamping Limboto terdiri dari sementasi, rekristalisasi, pelarutan dan penggantian. Lingkungan diagenesis terdiri dari *marine pheratic, meteoric phreatic* dan *vadose*. Proses diagenesis seperti porositas *fracture* dan *vuggy* terbentuk akibat pengaruh tektonik yakni pengangkatan cepat ke permukaan sehingga terjadi pelarutan.

Analisis data primer pola kelurusan SRTM dan analisis korelasi stratigrafi regional didukung analisa data sekunder paleomagnetik membuktikan bahwa Lengan Utara Sulawesi terdiri dari dua lengan. Dua lengan tersebut yakni Lengan Utara Bagian Barat dan Lengan Utara Bagian Timur. Lengan Utara Bagian Barat secara evolusi tektonik mengalami rotasi searah jarum jam sebesar 60^{o} sedangkan Lengan Utara Bagian Timur berotasi sebaliknya berlawanan arah jarum jam sebesar 20^{o}. Kedua Lengan Utara kemudian mengalami *amalgamation* pasca pengendapan batugamping Limboto.

Hasil analisis cekungan Limboto menunjukkan bahwa model cekungannya adalah laguna. Genesa cekungan Limboto merupakan laguna dimulai pada kala Miosen Akhir. Kala Miosen Akhir terjadi aktivitas tektonik *subsidence* di Lengan Utara Bagian Timur dengan kecepatan sebesar 0,0855-0,0934 mm/tahun. *Subsidence* ini berimplikasi terbentuknya Cekungan Limboto dengan lingkungan *brackish lagoons and estuaries* dengan arah laut terbuka di barat laut. Hal ini terjadi karena pengaruh subduksi Lempeng Sula dari selatan yang menyebabkan terjadi pengangkatan vertikal dengan terjadinya aktivitas vulkanik Pinogu. Karena Cekungan Limboto awalnya merupakan *back arc basin* padahal di sisi utara, subduksi Lempeng Laut Sulawesi mengangkat deretan vulkanik tua secara vertikal. Kondisi ini membuat Cekungan Limboto yang ada di bagian tengah antara dua morfologi tinggi mengalami *subsidence*. *Subsidence* di Cekungan Limboto ini diikuti proses pengendapan Formasi Limboto.

Kala Pliosen Awal, Cekungan Limboto mengalami *uplift* akibat subduksi Lempeng Sangihe dari timur ke barat yang menumbuk Lempeng Sula yang menyebabkan sudut tunjaman Lempeng Sula membesar. Kondisi sebaliknya justru terjadi pada Lempeng Laut Sulawesi yang bergerak dari utara semakin dalam tunjamannya mendekati Lempeng Sula sehingga membuat Cekungan Limboto mengalami *uplift*. Implikasi *uplift* membuat lingkungan pengendapan mengalami *relative sea level drop* berubah menjadi *normal marine lagoons* and *carbonate platforms*.

Rekonstruksi tektonik yang terjadi pasca terbentuknya Formasi Limboto yakni memasuki Pliosen Akhir terjadi rotasi Lengan Utara Bagian Timur berlawanan arah jarum jam. Rotasi sebaliknya justru terjadi di Lengan Utara Bagian Barat yang searah jarum jam. Rotasi kedua lengan ini masih dibarengi proses *uplift* Cekungan Limboto hingga akhirnya memasuki kala Pleistosen Awal terjadi *amalgamation* sehingga terbentuk Danau Limboto. Perubahan lingkungan pengendapan ini diikuti sedimentasi endapan danau di atas Formasi Limboto dengan hubungan stratigrafi tidak selaras dengan ketebalan mencapai lebih dari 80 meter yang berlangsung hingga sekarang.

Kata Kunci : Cekungan Limboto, Diagenesis, Evolusi Tektonik, Fasies, Lingkungan Pengendapan, Umur Batugamping

ABSTRACT

The Limboto Basin is a basin in the centre of the North Arm of Sulawesi. The characteristics of this basin are very complex with the presence of late tertiary limestone. This condition is a challenge to conduct more detailed research on the existence of Limboto limestone. This limestone research at the same time helped unravel the mystery of the formation of the Limboto Basin, which until now is still confusing.

The main objectives of this study include analyzing facies, depositional environment, relative age of limestone, processes and environment diagenesis of the Limboto limestone and creating the Limboto Basin model. Efforts to achieve the research objectives are then used four research methods and analysis. The four research methods and analyzes consist of measured section, petrography analysis, biostratigraphy analysis and structural geology (tectonic) analysis.

The results of this study resulted in new findings regarding the facies and depositional environment. The Limboto limestone facies consist of five facies. *Coralline rudstone* and *coralline floatstone* facies (SMF 24) with *platfom interior restricted* environment (FZ 8). *Bioclastic rudstone* facies (SMF 12) with *platform margin sands shoals* environment (FZ 6). The *foraminiferal wackestone* facies (SMF 9) and *wackestone-packstone intercession* facies (SMF 10) with *platform interior open marine* environments (FZ 7).

Limboto limestone age based on the results of biostratigraphy analysis is Late Miocene-Early Pliocene refers to the division of three biostratigraphy zonations. *Globorotalia acostaensis* partial range zone (PL1/N18), *Pulleniatina primalis-Globoquadrina dehiscens* concurrent range zone (M14/N17b) and *Globorotalia plesiotumida* partial range zone (M13b / N17a).

The Limboto limestone diagenesis process consists of cementation, recrystallization, dissolution and replacement. Diagenetic environment consists of marine pheratic, burial, meteoric phreatic and vadose. Diagenetic processes such as porosity fracture and vuggy are formed due to the influence of tectonics, namely rapid removal to the surface resulting in dissolution.

Primary data analysis of SRTM alignment patterns and regional stratigraphic correlation analysis supported by paleomagnetic secondary data analysis proves that the North Arm of Sulawesi consists of two arms. The two arms are the Western North Arm and the Eastern North Arm. The Western North Arm is tectonically evolved clockwise rotation by 60^{o} while the Eastern North Arm rotates counter-clockwise by 20^{o}. Both North Arms then experienced amalgamation after the deposition of the Limboto limestone.

The results of the Limboto basin analysis show that the basin model is a lagoon. The Limboto basin is a lagoon that began in the Late Miocene. When the

Late Miocene occurred, tectonic subsidence activity in the Eastern North Arm with a speed of 0.0855-0.0934 mm/year. This subsidence implies the formation of the Limboto Basin with a brackish lagoons and estuaries environment with the open sea in the northwest. This happens because of the influence of the subduction of the Sula Plate from the south which causes vertical uplift with Pinogu volcanic activity. Because the Limboto Basin was originally a back arc basin whereas on the north side, the subduction of the Sulawesi Sea Plate raised vertically old volcanic rows. This condition makes the Limboto Basin in the middle between two high morphologies experience subsidence. Subsidence in the Limboto Basin is followed by the process of deposition the Limboto Formation.

During the Early Pliocene, Limboto Basin experienced an uplift due to subduction of the Sangihe Plate from east to west which pounded the Sula Plate causing the angle of subsidence of the Sula Plate to enlarge. The opposite condition actually occurs in the Sulawesi Sea Plate which moves from the north deeper into subduction near the Sula Plate so as to make the Limboto Basin experience an uplift. The uplift implications make the depositional environment experience a relative sea level drop turned into normal marine lagoons and carbonate platforms.

Tectonic reconstruction that occurred after the formation of the Limboto Formation ie entering the Late Pliocene, the rotation of the Eastern North Arm opposite the clockwise direction. The reverse rotation actually occurs in the Western North Arm which is clockwise. The rotation of these two arms is still accompanied by the process of uplifting the Limboto Basin until finally entering the Early Pleistocene when an amalgamation occurs so that Limboto Lake is formed. Changes in the depositional environment were followed by sedimentation of lake sediments above the Limboto Formation with stratigraphic relationships not in harmony with thicknesses reaching more than 80 meters that have continued to the present.

Key Words : Limboto Basin, Diagenesis, Tectonic Evolution, Facies, Depositional Environment, Limestone Age